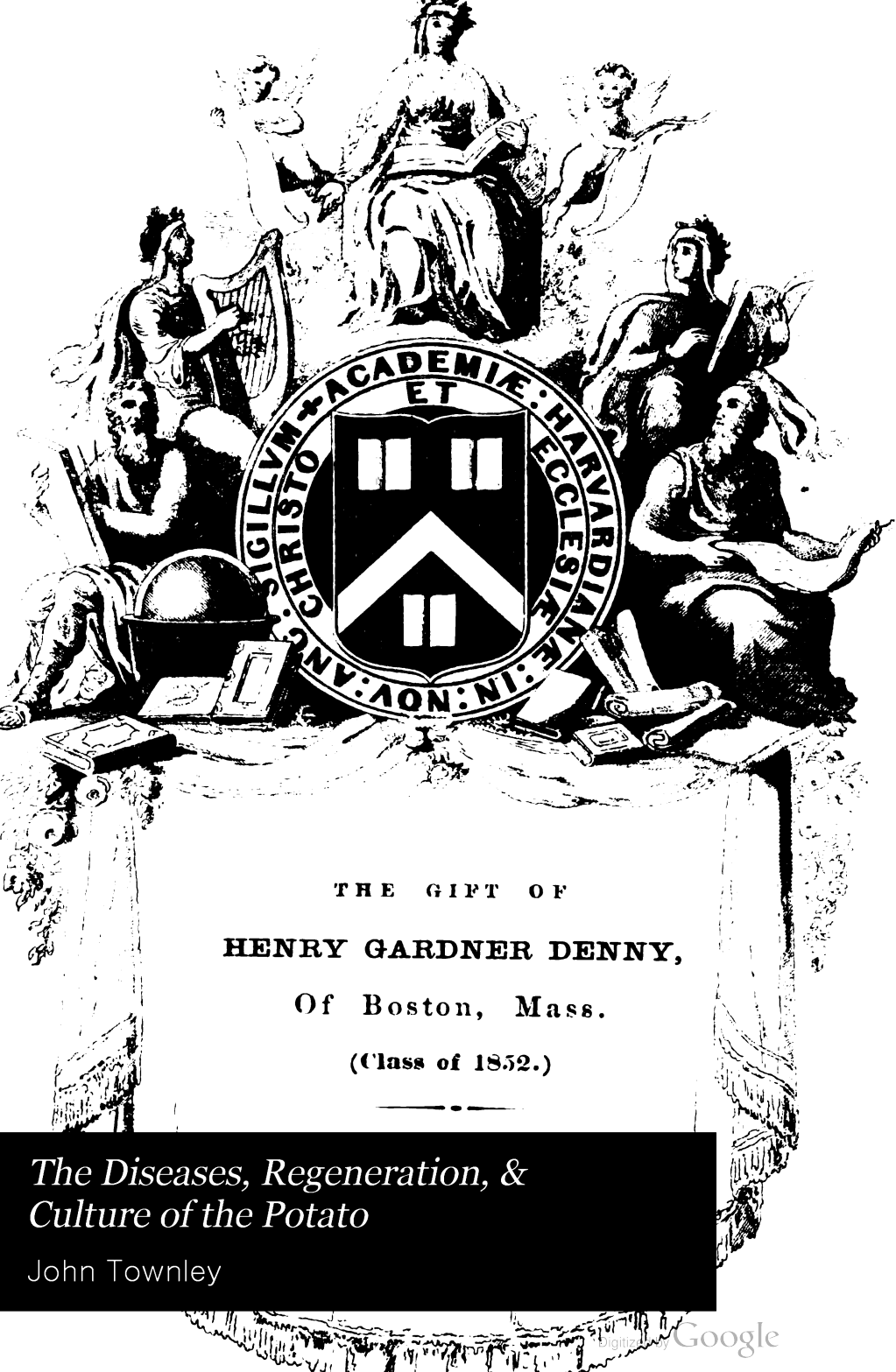
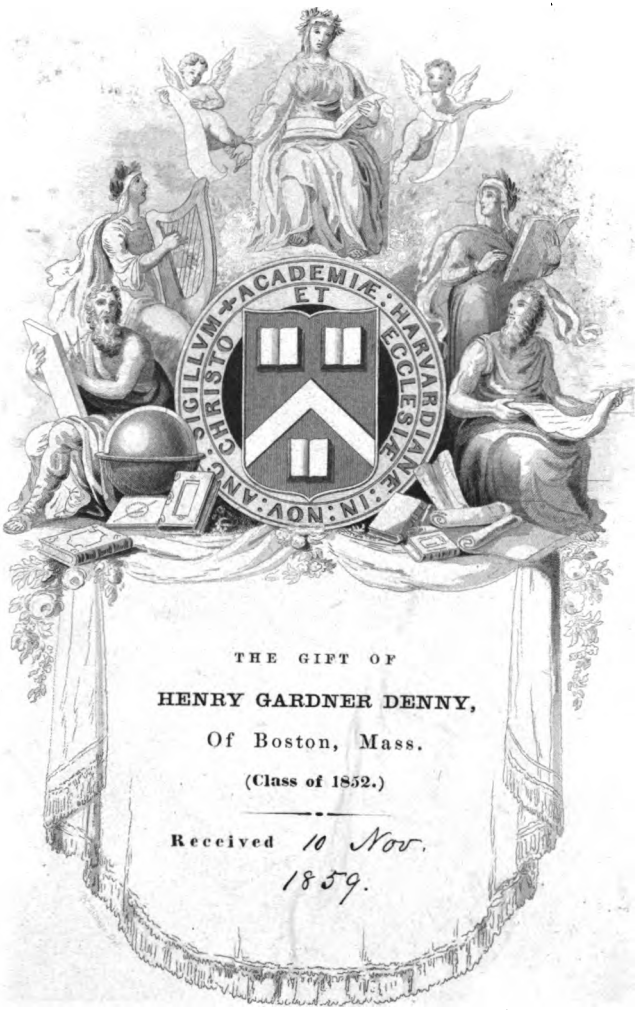
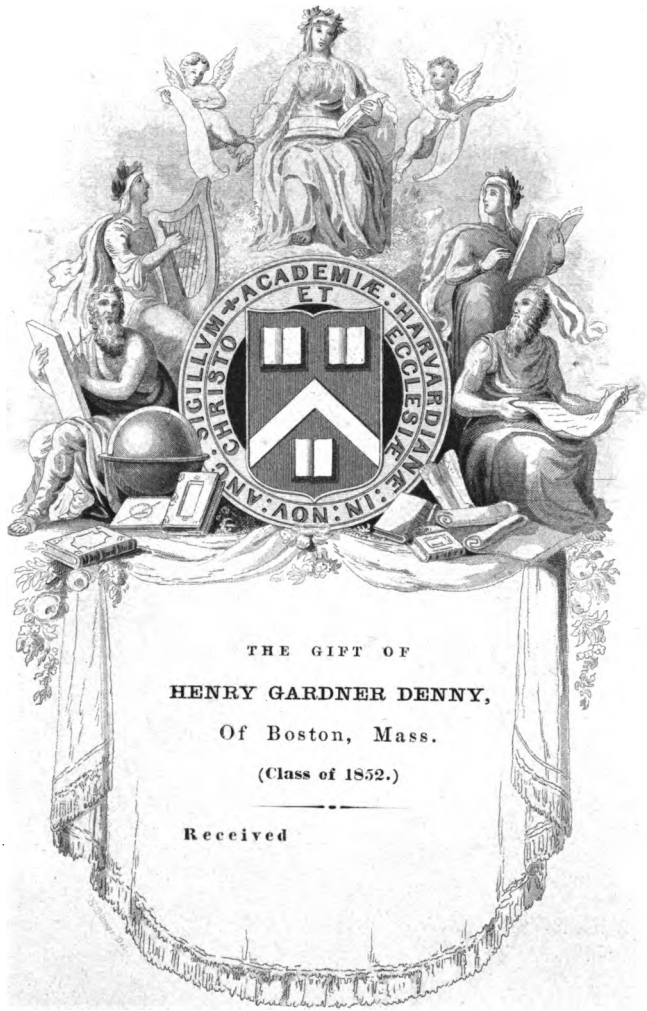


The Diseases, Regeneration, & Culture of the Potato

John Townley





THE

DISEASES, REGENERATION, & CULTURE

OF

THE POTATO:

CONTAINING AN

EXAMINATION OF THE ROYAL AGRICULTURAL SOCIETY'S PRIZE ESSAYS ON THE "BLIGHT;"

A REPLY TO DR. LINDLEY, ON THE WEARING OUT OF PLANTS;

AND SHOWING WHAT ARE THE PREDISPOSING AND EXCITING CAUSES OF THE POTATO DISEASE,—WHAT THE BEST MEANS OF MITIGATING ITS EFFECTS, AND OF ULTIMATELY RESTORING THE PLANT TO HEALTH.

By JOHN TOWNLEY.

"Nature is not to be conquered except by obeying her."—Bacon.

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PREFACE.

It may be necessary in the outset to state, in as few words as possible, why I have been induced to examine a question which has baffled the skill of numerous individuals, distinguished for their scientific attainments.

About ten years ago I wrote several letters on horticultural subjects, which were printed in a provincial paper—the Preston Pilot. One of these letters was on the dry rot disease of the potato, at that time prevalent to a considerable extent. I forwarded a copy of the newspaper containing this letter, to the late T. A. Knight, Esq., then President of the Horticultural Society, thinking it would afford him some pleasure to learn, that an attempt, however humble, was being made to induce better modes of cultivation, based on a knowledge of natural laws. To my gratification Mr. Knight wrote to the Editor of the Pilot, in confirmation of the accuracy of my views respecting the cause of dry rot, and the remedy to be applied, requesting, at the same time, that I would furnish him with my address. This circumstance led to a correspondence between us, which ended only with his lamented death; and as a letter on the potato was the means of introducing me to a man who, by his interpretation of the laws of vegetable life, had conferred such inestimable benefits on mankind, I was, perhaps, thus led to take more than ordinary interest in anything relating to that plant.

When, therefore, Dr. Salter's letter in the Gar-

deners' Chronicle announced the appearance of the blight, my attention was immediately excited, and I carefully noted the statements of subsequent observers. I had many reasons to be dissatisfied with the unfortunate explanation of the disease broached by Dr. Lindley, but was unable to find a better, when a note appeared from Mr. Berkeley, stating that he had observed a parasitic fungus preceded the destruction of the plant. This suggested to me the predisposing cause of the disease, and I saw at once how this predisposition must have been induced. It was now clear to me why many young varieties were attacked by dry rot and blight equally with the oldest. I then became convinced that the disease was of no temporary character, and by what means only it could be eradicated. In short, a review of the observations which had been made up to that period, discovered to me that the hitherto discordant facts now formed one harmonious whole, and from that hour I was persuaded that the question was settled.

I continued for a few weeks noting numerous observations, as they poured in from various parts of the country, and all further consideration assured me that my view of the nature of the disease was well-founded. And knowing the danger which was to be apprehended from extensive and successive failures of the potato crop, I felt it to be a solemn duty to warn the country, that this evil was not of any transitory character, and to state the grounds I had for arriving at such conclusion. In accordance, therefore, with this conviction, I sent a letter to the Editor of the Times, on the 8th of October, 1845. Three or four weeks afterwards I wrote another letter, a copy of which I forwarded to the Government. I also forwarded a copy to the Editor of the Morning Herald. My best thanks are due

to that gentleman for the promptitude with which he inserted the letter.

The Commissioners' Report on the cause of the disease, appeared in the same Number of the Herald as that which contained my letter. The conclusions arrived at by the Commissioners and myself respectively, were at variance, and as Dr. Lindley endeavoured, in the Gardeners' Chronicle, to support the Commissioners' views, and to disparage those I entertained, by statements which seemed to me to be opposed to well-established facts, I forwarded two other letters to the Herald, seeing no other means of arriving at a more truthful view of the whole case, than by bringing forward additional facts, and courting a more searching inquiry. Dr. Lindley did not reply in the Herald, but he published two articles in the Gardeners' Chronicle, the object of which was to show that my explanation of the cause of the malady was not well-founded.

I subsequently wrote three other papers; one being on the best means of renovating the health of the plant—one, an examination of Dr. Lindley's two articles—and one, an examination of lectures on the blight, delivered before the English Agricultural Society. A copy of this last paper, (showing how utterly impossible it was that the disease should be owing to the supposed unfavourable season of 1845), I forwarded to the Government early in February 1846. Copies of these papers were forwarded to the Royal Agricultural Society of England, to the Highland and Agricultural Society of Scotland, and to the Royal Irish Agricultural Improvement Society.

In the autumn of 1846, I wrote another paper, exposing the fallacies of sundry hypotheses which had been recently advanced, and showing how the

experience of that year, and observations made in other countries, confirmed the accuracy of my views. This paper being finished during the recess of the Royal Agricultural Society, was forwarded direct to Mr. Pusey, the Chairman of the Journal Committee. It was not sent with a view to compete for the prizes offered by the Society, (as I was precluded by two conditions) "but in the hope that it might prove useful to them in their endeavours to discover the cause of the potato disease."

Every essential conclusion that I arrived at in 1845, respecting the blight, has hitherto been confirmed; no other explanation has stood the test of time, or will now so satisfactorily explain all the facts; and as the English Agricultural Society has awarded its prizes to essays which ascribe the disease to the wet and cloudy nature of the season of 1845, I do feel it incumbent on me to publish my views in some permanent form, and so leave time, and time's sure effects on the public mind, to determine on whose side is truth.

J. T.

London, May 1847.

INTRODUCTION.

THAT it is desirable to ascertain, if possible, the cause of the disease of the potato, and whether by any means we can subdue an evil, the fearful effects of which we already know, whose future influence is a source of well-grounded anxiety, and the consequences of which no man can foresee, would appear to be a self-evident proposition.

The last year's loss in the potato crop of Britain only is estimated at £12,000,000. Upwards of four millions of the population of Ireland have subsisted chiefly, we may say entirely, on the potato, and apart from this disease in the crop, great distress, arising from a scarcity of food in early summer, has been something like an hereditary evil in that country. The potato has also been the principal support of the poorer classes in the Highlands and Islands of Scotland, and it has hitherto been considered an almost indispensable article in the diet of all classes in England.

The agricultural produce of the United Kingdom, on an average of years is not equal to the wants of its inhabitants, coupled with which we have a peculiar danger attending extensive failure or loss of the potato, arising from the well-known fact that this esculent affords a greater amount of human food from a given space of land, than any other crop whatever. The produce of the Swedish turnip may, in suitable soils and favourable seasons, equal or exceed that of the potato, but it is a crop subject to many accidents; partial failures occur almost every year; extensive failures are not unfrequent; and, however useful as food for cattle, the turnip would be, and has been found on trial, only an indifferent substitute for the potato as food for man. The same may be said of carrots and parsnips. Notwithstanding the numerous receipts in the columns of newspapers for cooking these roots, with a view to make them palatable in daily use, bread or other farinaceous food is now generally used in preference to them.

Peas and beans were in former years extensively used in this country. But of all crops these are the most precarious, and can only be grown on certain soils with advantage. They contain, it is true, more nutriment; more of the elements which enter into the composition of the animal frame, as compared with matter chiefly required for respiration, than the potato, yet they are not generally palatable, and their produce, on an average of years, will not

afford sustenance to half the number of people as would the same extent of land under potatoes. This is a sufficient answer to a question which has been asked, viz., why should not these crops again supersede the necessity for the potato.

There is obviously no better prospect of relief by sowing a greater breadth of our arable land with wheat or other grain, which has also been suggested. Much of the improvement in British agriculture of late years, is, as is well-known, the result of a more judicious rotation of crops, by which corn is not grown two or more years in succession as formerly. But even supposing this more judicious rotation could be laid aside without impoverishing the land, and thus diminishing the succeeding crops, still we should not be able to supply the void caused by the loss of the potato; because one acre of potatoes will, on the very lowest calculation, maintain a given number of people as long as two acres of wheat. As we have no root, then, which can be considered to be an equivalent for the potato, and as no pulse or grain crop, can yield individually anything approaching the same amount of food per acre as the potato, neither can they do so collectively, for each requires as long a time as does the potato to bring it to maturity. If, then, the culture of the potato is to be abandoned, or if it be extensively cultivated, and the present disease should continue, it must be evident that, unless an extraordinary effort is made to increase our supplies, by increasing the fertility of the land in cultivation (of which there is little prospect), the agricultural produce must fall far short of the wants of the people. And as a consequence of this, we must continue to import a great amount of food from other countries; the prices of provisions will necessarily remain high; and the distress and sufferings of the poor will, to all appearance, be perpetuated.

As the failure of the potato has led to these evils, its speedy renovation would, of course, be their most effectual remedy, and therefore an enquiry into the cause of the disease with a view to its prevention is all important.

Many, however, I am aware, will not willingly subscribe to this. We shall be told that the potato is at best but a precarious crop. The reply to this is ready, and tends in no small degree to enhance the value of the potato, when contrasted with its compeers in the vegetable world. They who contend that the culture of the potato should be abandoned on the ground that it is a precarious crop, can know little of the previous history of the plant, for however uncertain it may have become of late years, it was formerly considered to be the most certain of all crops, and hailed as the palladium against famine.

Even the Royal Society, so long back as 1663, endeavoured to encourage a more extensive cultivation of the potato, with a special

view to prevent the recurrence of famines. And that famines were prevented in a great measure by the certainty of the potato as compared with other crops appears from the observations of many distinguished agricultural writers. Mr. Mc Adam of Belfast, in a lecture on the potato, remarked, "the potato has this superiority over all kinds of grain, it is perfectly secure against those heavy late rains which so often destroy the hopes of the farmer. It has placed us beyond the reach of those frightful famines which in former times so often devastated the land."* The experience of the late President of the Horticultural Society warranted him in saying, "there is not any crop which I conceive to be so certain as that of potatoes, and it has the advantage of being generally most abundant when the crops of wheat are defective: that is, in wet seasons."† Sir John Sinclair observed, "in times of scarcity and distress there is no article comparable to potatoes." Mr. Curwen, also, in his work on Ireland, has this remark, "as a security against famine the potato is invaluable."‡

Again, it is urged, that the potato is a great evil, a coarse food, unfitted for the sustenance of man, the cause of the misery and degradation of the peasantry of Ireland, and that its entire destruction would be attended with great advantages. But this will turn out to be mere declamation, when we come to enquire for the *rationale* of the assertions. Granted, that the potato is an evil, (not in itself, to be sure, but in the use which has been made of it,) still, one would think that a bare statement of its comparative value, similar to that just given, will award to it no mean place in the category of what are termed "necessary evils." The potato has been found superior to all roots in its feeding properties, when given to cattle. Men have been reared and maintained in health by means of the potato alone, a feat which even wheat itself is not able to accomplish. It is the only root which can be cultivated in our climate, which may be eaten every day without satiating the palate; and Mr. Knight has stated good grounds for concluding, that the use of the potato has contributed to some extent to the better health, and the greater duration of life of the people of this country, which has been observed during the last century.§ Yet, chemists overlooking all this, endeavoured, in 1845, to prove by analysis, that as food it is of little value. But in 1846, I find them endeavouring, by the same means, to reconcile the people to the use of mangold wurzel. Another writer, who considered that the prospect of losing the potato was a matter for congratulation rather than otherwise, and who con-

* Quar. Jour. of Agric. 1835, p. 342.
† Knight's Phys. & Hort. Papers, p. 319.
‡ Curwen on the State of Ireland, v. 2, p. 32.
§ Knight's Phys. & Hort. Papers, pp. 319, 320.

tended that it was really wicked to crop fertile land with such base food, is now compelled by the force of circumstances to say, "it is a matter of little moment how coarse and unpalatable the food may be, we must grow that which will produce the greatest quantity; and men of intelligence should remove the ignorant prejudices of the peasant, and tell him that what will keep an ox in condition, will feed a man, providing he can only digest it."

And as to the potato being the chief cause of the degradation of the Irish peasantry, let the meed be said, I am by no means indisposed to admit that by the facility of its cultivation, and by affording a greater amount of food with less labour than any other crop, the potato will contribute to the idle propensities of a people such as the Irish are said to be, whether justly or unjustly is not for me to decide. Be this as it may, it is a sufficient answer to this cry, of a two-fold potato disease, to ask, why are not the peasantry of this country equally degraded with the peasantry of Ireland? or to put the question in another form, how is it that the agricultural labourers of Wilts, Devon, and Dorset are more nearly on a level with those of Ireland, than they are with those of Lincolnshire? But let us even put this aside, and take our stand on one great fact. To supply the void which would be created throughout the length and breadth of the United Kingdom by the "entire destruction" of the potato—hic labor, hoc opus est! There *is* a mass of human beings who have been reared on the potato, who, till lately, have known no other food, and the question to be considered, the difficulty to be met full in the face without any equivocation unworthy a great nation is, how are these human beings to be maintained in future years, without the aid of the potato. And, if in former times before the discovery of this plant, the people were subject to famines by the failure of those crops which are so much more liable to be injured by adverse seasons, what would be the condition of the country, with its immensely increasing population, already beyond what the land can, or at least does support, if the potato should be annihilated, and a season like that of 1799, or 1816, or even 1829, should appear again, and the recurrence of such a season is by no means an improbable event?

The regeneration of the potato is a matter of life or death to thousands, and I am persuaded that the only safe conclusion to be arrived at, may be summed up in the words of Mr. Andrew Knight. "Whatever may have been the amount of advantage or injury which the British nation has sustained by the very widely extended cultivation of the potato, it is obvious that under the present circumstances it must continue to be very extensively cultivated; for though it is a calamity to have a numerous population compelled by poverty to live chiefly on potatoes, it would certainly be a much greater calamity to have the same population without their having potatoes to eat."

ON THE BLIGHT OF THE POTATO.

THE disease of the potato known as the "blight," appears to have been first observed in this country in the county of Kent, late in the autumn of 1844. No satisfactory evidence can be found in our agricultural works to show that it ever appeared at any former period. The premature and gradual decay of the foliage of the plants generally, and the partial rotting of the young tubers in the ground, are the chief characteristics which distinguish the blight from all former diseases of the potato.

In all countries where the disease has been observed, the plants continue to grow in seeming health till the period of blossoming, or thereabouts. The first symptoms of the malady usually noticed are gangrenous blotches on the leaves. The blotches are dark brown on the upper surface, but on the lower surface, though brown in the centre, they are hoary or grey at, and a little beyond the margin. These spots gradually extend. Next the stems, mostly at the joints, assume a dull, livid, swollen appearance; afterwards some of the tubers, generally the largest and those which are nearest the stem or surface of the soil, exhibit a dark leaden-coloured patch under the skin, mostly, but not always at the end where the tuber is attached to the stem; this, under favourable circumstances gradually spreads, till the whole tuber is affected; and in the pits the diseased portion is observed to be covered with a white down or mould. In boiling, the diseased part of the tuber does not dissolve or waste away in the water, but remains hard when the sound portion is cooked; when broken it presents an oily or viscid appearance, and it has a peculiarly offensive taste and odour.

In some instances diseased tubers have been observed on an apparently healthy plant; in others livid patches have first appeared on the stems of a portion of the plants of a crop, and the foliage shortly afterwards drooped and withered, or else became spotted with blotches of an uniform dark colour on the under as well as on the upper surface of the leaf. Another disease which has been observed in several localities of late years, presents somewhat similar features to the blight. The tubers become diseased in the ground, and the plant dies prematurely. But in this malady the tubers are spotted with "pock-marks" or small dark ulcers,

and the affected plants assume a yellow, sickly colour. The attack, moreover, is not general but partial, a plant here and there is affected by it, whilst others continue healthy; whereas, if a crop is attacked by the blight, especially if it be at an early period of its growth, the plants on a superficial view may present an uniform healthy appearance, yet the peculiar corroding blotches may be developed on the lower and shaded leaves of the plants generally.

Dr. Lindley has stated several so-called facts regarding the symptoms, development, and geographical range of the disease, which he considers must be satisfactorily explained before the problem of the potato disease can be said to be solved. I therefore quote them:—

1. It has for some years past been violent in St. Helena.
2. It appeared in 1845 at Genoa, and Lisbon, and Graham's Town in the Cape colony, exclusively in potato crops obtained from English seed, and therefore of the growth of 1844.
3. It appeared in 1845, in the Bermudas, in fields cropped with potatoes obtained from the United States, and not in those which had been cropped with Bermuda sets.
4. It has broken out at New Holland.
5. It was little known in bog or moss land in 1845, and now has broken out there with as much violence as elsewhere.
6. It is accompanied with an increased excitability of the tubers, both young and old.
7. It invariably begins as a brown decay of the bark of the potato stem, underground, and an inch or two above its origin from the old set.
8. It has broken out in England in 1846, in crops obtained in well-drained unmanured land from sets imported from Naples, the Azores, Oporto, and New Grenada, every one of which places was reported to be uninfected.

It may be well, at the outset, to notice some of the more plausible hypotheses which have been advanced in explanation of the blight, and to state briefly the objections which I entertain against those which seem to me to be untenable. I take Dr. Lindley's list of the principal causes which have been suggested. 1. The bad season of 1845. 2. Frost. 3. Lightning. 4. Insects. 5. Guano. 6. Bad cultivation. 7. Exhausted vitality. 8. Miasmata. 9. Parasitical fungi; and to these he might have added, 10. a degenerate state of the plant, as the predisposing cause, and a parasitic fungus as the immediate or exciting cause. I have objected that the disease could not possibly be owing to the cold, wet or cloudy nature of the season of 1845.

1. Because the potato was formerly considered the palladium

against famine, producing with certainty, tolerable crops in adverse seasons when most other crops were deficient, and the failure had occurred in a year when all other crops, wheat perhaps excepted, were abundant.

2. Because a moist season, such a one as suited the oat crop, had hitherto been found most favourable to the growth of the potato, and the oat crop of 1845 was one of the most abundant ever reaped in this country.
3. Because a reference to meteorological tables and to agricultural reports, proved that the summer of 1829 was as cold, nearly twice as wet, more cloudy, and much more unfavourable to vegetation generally, than the summer of 1845, yet no such disease of the potato was then developed.
4. Because the disease did not appear simultaneously throughout the country, like the diseases of animals, arising from a peculiar state of the weather, but like the epidemic diseases of animals (which are supposed by some to be propagated by the spores of fungi, or atmospheric animalcula), it commenced at a certain point and travelled.
5. Because the plague was not stayed on the return of fine weather as was predicted, but progressed as steadily as when the weather was cold and wet.
6. Because it was experienced in Kent in the autumn of the fine dry summer of 1844; and nearly destroyed the whole crop in a part of America in the midst of an intense and long-continued drought.
7. Because it had been experienced in St. Helena, an island within the tropics, five or six years, and in North America three or four years in succession, and it was not proved and could not be considered probable, that precisely the same adverse weather had been experienced in so many different countries so wide apart, and this for the first time during the two centuries the plant had been in cultivation.
8. Because they who ascribed the disease to atmospheric influences, differed widely in their opinions as to the precise nature of the weather and its mode of action; they moreover stated arguments tending to show that the conclusion which each had arrived at was erroneous and unsatisfactory.

The Commissioners appointed by Government to inquire into the cause of the potato disease, have long since acknowledged that they had arrived at an erroneous conclusion when they attributed it to the bad season of 1845. And one might reasonably have supposed from the additional experience of the last hot and droughty summer, that it would now be universally admitted that no explanation of the cause of the blight could be more obviously untenable. I need therefore hardly say, that I have been sur-

prised to find that the Royal Agricultural Society of England have countenanced the opinion that the disease was caused in 1845 by "excessive moisture and deficient light," by awarding their three prizes to gentlemen who have adopted this view of the question.

Almost any one of the reasons above stated is enough to shew that this hypothesis is not adequate to account for the disease; taken together, surely they leave no room for doubt. I might therefore content myself with this bare statement as the ground of my objection, and so pass on to other assigned causes. But the decision of a powerful society exercises considerable influence on the minds of those who may not be well qualified to judge for themselves in this matter, owing to a want of the requisite scientific and practical knowledge which bears upon the question. A somewhat novel attempt has also been made to account for the action of adverse weather on the potato, founded on a view of the nature and functions of the various organs of the plant. Some additional remarks are therefore necessary.

The author of the first prize essay (Mr. Phillips) has entered into an elaborate calculation, in order to shew what a great extent of roots and what a number of spongioles, or absorbents, belong to a healthy potato plant, and on these data he concludes that the potato is most fitted for a dry situation, therefore wet soils or seasons must be adverse to the plant and cause it to decay. By the same process of reasoning, Mr. Phillips infers that the turnip requires very different conditions for its healthy growth, and says, "if a potato and a turnip are planted in the midst of moisture, the latter, with its comparatively small system of roots, will flourish, while the former will overload itself and die of repletion.

Farmers, generally, are averse to theory; but they entertain an opinion that nature adapts certain means to a certain end. The turnip has a large system of leaves; some farmers are, therefore, apt to conclude that it derives its nourishment chiefly from the air; but the carrot, having light feathery foliage, they consider depends chiefly on the soil for its food. Thus, from the same data, they would arrive at the very opposite conclusion to that of Mr. Phillips; they would infer, that the extensive roots of the potato were an indication that the plant required a plentiful supply of food from the soil rather than otherwise.

The roots of plants, however, afford no certain criteria whereby to determine what soils may be most suitable for them. In the same soil the roots of different species of wild plants differ greatly; and were we to be guided in practice, by Mr. Phillips' theory, we should grow our carrots and cacti in swamps.

But surely there are far better means than this of ascertaining what soils and situations, on an average of years, are

most suitable to the growth of a given plant. If Mr. Phillips were to appeal to practical men, their unanimous decision will be, that the potato could be grown with advantage in more soils and situations than any other crop whatever; and that those soils and seasons, which were most favourable to the growth of the turnip, are precisely those which were most favourable to the growth of the potato. And however much a somewhat damp atmosphere, or frequent showers, may contribute to the welfare of the turnip, wet, or very moist soils are certainly not advantageous; on the contrary, it is well known that 'light, dry, and friable soils' are usually called by farmers "turnip lands," in consequence of the plant succeeding so much better on them than on land of a moist and tenacious character.

What then can be the value of an explanation of the potato disease, based on such an obviously visionary foundation?

Besides, have not Lancashire and Ireland been considered to be especially favourable to the growth of the potato, in consequence of the climate of these places being so much more humid than most other parts of the United Kingdom? Is it of no consequence in this inquiry, to know that the potato was formerly "secure against heavy late rains, which destroyed the hopes of the farmer;" and that it generally yielded the greatest produce in wet seasons? Phillip Howard, the Meteorologist, observed, "in the *very wet* 1828, the rain fell chiefly in *summer*, so that we had potatoes a pound and a half in weight, and the *crop unequalled* in the whole cycle of eighteen years."* According to Mr. Howard's observations, the greatest amount of rain which fell in the summer quarter of any of the eighteen years, was in 1828; and it was nearly double the quantity which fell in the same period of 1845. Yet this excessive moisture, instead of inducing putrefaction of the plants, considerably increased the produce.

And, before we can subscribe to Mr. Phillips' theory, is not some explanation required why, in 1845, potato crops became diseased when "the ground was quite parched two inches below the surface?"† Why "plants, grown on a vine border made of lime rubbish, oyster shells, and other dry materials, and thoroughly tile-drained, were as much affected as on the moist and less drained land adjoining?"‡ Why "plants, on the chalkiest and driest fields, were amongst the worst of the bad?"§ Why two or three weeks sometimes intervened between the attack on two different varieties growing on the same soil? and why

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* Howard's Cycle of the Seasons of Britain, p. 10.
† Gard. Chron., 1845, p. 592.
‡ Ibid. p. 624.
§ Ibid. p. 674.

some have continued healthy in the midst of others which were diseased?

How, too, can we reconcile with this theory the important fact, that the crops in the Highlands, and Islands of Scotland, were destroyed in the sunny season of 1846, while they continued growing in seeming health to the end of the gloomy season of 1845? Or, why the disease should break out in England in 1846, in crops obtained on well-drained land, from sets imported from Naples, the Azores, and other places which were reported to be uninfected? There was no similarity between the two seasons; and these facts are of themselves sufficient to prove, that the supposed wet and cloudy nature of the season of 1845 could not be the sole cause of the potato disease. This might be considered a sufficient answer to a question asked by the author of the Second Prize Essay, viz. "When had we such a summer as 1845—such extreme heat succeeded by long continued gloom and chilly rains?" This question has been repeatedly asked, and for the satisfaction of gentlemen who make the inquiry, I beg to refer them to the agricultural reports for 1799. I apprehend they will then be thoroughly convinced, that a sudden transition from heat to cold, or long continued cold and wet weather, could not possibly be the only cause of the disease in 1845. The spring of both 1799 and 1845 was a late one; in 1799, "dry weather from the middle of June to the end of July produced a *most surprising alteration*, and wheat seldom appeared better;" exactly as in 1845. But now mark the difference between the two seasons; "early in August, heavy rains, accompanied with cold easterly winds, reduced the summer fallows and turnip fields to a perfect mire; half rotted a great part of the hay; stopped the growth of the second crop of clover; laid down all the strong corn, and effectually prevented the wheat from filling. The month of September was, on the whole, rather worse; indeed, the strong corn lay soaking among water during the greater part of it, and much of the wheat, from excess of moisture, died at the root before the ear ripened."* "Aqueducts and the banks of canals gave way; almost all the bridges on five rivers in Lancashire were destroyed; numerous mills and houses in various parts of the kingdom were swept away, and, at one time, travelling was nearly suspended."† And how fared the potato in that disastrous year? It was then extensively cultivated, and, like hay, the stems of wheat, and other vegetable substances, it may be macerated or rotted by being soaked in water. Potatoes were certainly injured to some extent as well as other crops; but,

* Farmer's Mag., 1800, p. 101.
† Morning Chron., Aug. 26, 1799.

instead of finding them a mass of putrefaction, and the loss of the crop forming a prominent topic in the speech from the throne, in the debates of parliament, and in the leaders of newspapers, I learn from Phillip Miller that this remarkably adverse season "rendered the utility of the potato so conspicuous, that it became extensively cultivated in most parts of the kingdom."*

But then it is objected that it was not the wet and cold merely, but "the peculiarly sunless nature" of the season of 1845 which led to the disease. Mr. Phillips states that the season was unusually cold and wet, and marked by a continued absence of sun; that a plant cannot elaborate its products without the direct action of the sun's rays; that in the shade and at night the vital principle ceases its action, and a chemical one commences, oxygen is absorbed, carbonic acid is formed and disengaged, and if the gloom continues, ammonia is generated, and putrefaction ensues. Hence the conclusion; that the blight is a putrefactive disease, caused by excessive moisture, absence of the solar rays, and want of exhalation. Early in 1846, I forwarded to the Agricultural Societies a comparison of the weather and the crops of the years 1829 and 1845. I showed to them that the temperature of July, August, and September of both years was nearly alike, or a trifle in favour of 1845. But in these months of 1829 there fell 13.01 inches of rain, while in the same period of 1845 the rain amounted to 6.87 inches only. Clouds and sunshine unfortunately do not admit of that exact measurement as temperature and rain, but it so happened that I was on an excursion among the hills and dales of North Lancashire and Yorkshire about the time the disease appeared in 1845; I was thus led to take more notice of, and to remember the state of the weather, in consequence of its interfering with my pleasures, and, although generally, it was anything but seasonable, I can safely affirm, that it was not marked by a continued absence of sun. I appeal to the remarks appended to meteorological observations, and to the state of the crops generally in 1829 and 1845, in proof that the former season must have been more cloudy also than 1845. In the meteorological observations for July, August, and September 1829, published in the Hort. Soc. Trans., it is said, there were only about ten days of fine weather in July, and the character of the remainder of the three months was altogether so wet and unseasonable as is rarely witnessed—unusually cold, cloudy, and wet. There are similar observations on the weather in the report of the Quarterly Jour. of Agr. for October 1829; and respecting the crops, grain is reported to be generally inferior. "Peas and beans blossomed well, but were much kept back by the continued rains, and will

* Miller's Gardeners' Dictionary.

prove a deficient crop; there are exceptions, however, in particular districts. Turnips are a very indifferent crop."

Now of the crops of 1845, wheat I believe was the only one (potatoes of course excepted) in which there could be said to be any deficiency; and wheat is well known to require a bright dry summer to bring it to the greatest state of perfection. Oats were said to be much above the average. Barley, peas and beans, average crops. Turnips, instead of being "a very indifferent crop," was one of the most abundant ever known; to use the words of an eminent agriculturist, in 1845, "The crops of carrots were excellent, those of mangold-wurzel and turnips never more generally abundant." In fact we heard on all sides, amidst the almost universal failure of the potato, congratulations respecting the super-abundance of most other vegetables. A showery season, it is true, may be more favourable to the growth of many of these plants, than a dry sunny one; but I believe it is utterly impossible, that they could have reached such a degree of perfection if the season had been unusually cold, cloudy, and ungenial; and there must obviously have been something very unusual indeed in the weather, to cause, without any change in the constitutional vigour and hardiness of the potato plant, such a wide-spread destruction for the first time during two centuries.

Light is essential to the welfare of plants. Some indeed thrive in the shade, and cannot bear the direct action of the solar rays; but with only diffused light, or in cloudy weather, the process of assimilation proceeds but slowly in plants cultivated by the farmer. The matter which constitutes the tuber of the potato, the root of the carrot and turnip, and the substance of fruit and grain, is elaborated or prepared in the leaves by the action of light. And whenever a cold wet season occurs in which there is a great deficiency of sun light, there will invariably be found a corresponding deficiency in the quantity and quality of vegetable produce. I am sure that every one acquainted with this simple physiological law, must be convinced in his own mind, by a comparison of the crops of 1829 and 1845, independent of meteorological observations, that the summer of 1829 must have been every way much more unfavourable to vegetation than that of 1845, and as there was no such rot in the potatoes that year, how can we justly arrive at any other conclusion, than that the supposition of its having been caused by the cold, cloudy, and ungenial weather of 1845 is fallacious and cannot be defended. If we are to believe otherwise than this, and be satisfied with the Agricultural Society's explanations, then we must also concede, that there is no longer any truth in the axiom hitherto held good in physical science, that "like causes will produce like effects."

The 2nd and 3rd alleged causes of the potato disease, "frost

and lightning," are obviously too absurd to require further notice.

The notion that insects were the cause of the destruction, has been pronounced the "idlest of all speculations." They certainly not unfrequently damage various crops to a considerable extent, but insects have not generally been observed in unusual numbers on the potato plant, nor have they in any instance been satisfactorily proved to be the cause of the disease. Entomologists who are best acquainted with their habits, have decided that they are not the cause. Several different insects, moreover, are blamed for the mischief. The author of an early pamphlet on the blight, decided that it was owing to an insect like a spider; what, therefore, so obvious a remedy as—hot water? Another writer insisted that it was the work of a minute species of thrips; he had watched its habits narrowly, and there could no longer be any doubt about the matter. Next a green bug was observed on some diseased plants, the acrid fluid voided by the insect was rubbed on to a healthy leaf, and, lo! the spot became brown, exactly as in the diseased leaves. The question was settled. And an account of the discovery, accompanied by a clergyman's certificate of the respectabilty and trustworthiness of the observer, was forthwith dispatchedto the Royal Agricultural Society. At length we hear that these gentlemen were all wrong, and that Aphides are the real delinquents. But will the evidence against them bear examination? In order to satisfy myself respecting the habits and numbers of the first named insects, and to investigate other alleged causes of the potato disease, I examined scores of acres of potatoes during the last summer, and I think it is hardly possible that Aphides could have existed on the plants in such immense numbers as would be required even to *retard* their growth without my noticing them.

Potato plants have been attacked by the disease in January of the present year, yet not a single Aphis could be observed on them.* Many facts might be mentioned which Aphides will obviously not explain. But it is sufficient to state, that the Aphis named "vastator," by Mr. Smee, is identical with a species described as Aphis rapæ by Mr. Curtis, in the Agricultural Society's Journal of 1842. Previous to that time, Mr. Curtis had counted 168 of these insects on one small turnip leaf; they were obviously in great force then, yet there were no indications of this disease in the potato at that time. Besides the turnip plant is the favourite food of this Aphis, not the potato. This is in accordance with Mr. Smee's observations, "I could not help observing," says he, "how much more stationary and tranquil this insect became when placed upon the turnip; he appeared to have got just what he wished for, and to be in a high state of self-satisfaction, not

* Gard. Chron. Jan. 23, 1847.

wandering about in search of anything better suited to his taste; whereas, when on the potato, he never seemed to be quite comfortable, but would be strolling about and trotting over the leaf, instead of sitting down at once seriously to his victuals." This observation, I submit, is amply sufficient to settle the question so far as Aphides are concerned.

Certain species of Aphides are known to prefer certain species of plants; Smee's "vastator" was named "rapæ" by Curtis, in consequence of its being the Aphis peculiar to the turnip (Brassica rapæ); Smee admits that it prefers the turnip to the potato, says that it has the power of destroying both plants; and yet in 1845, when in this country potatoes, for the first time during two centuries, were attacked with this disease, the turnip crop was so abundant and excellent generally, that in many instances turnips had to be sliced in the following spring, and put upon the land as manure for the want of stock to consume them,* and yet, despite of this, we are to believe that the turnip Aphis is the cause of the potato blight!

Some have supposed that guano was the cause of the disease. If it had appeared exclusively where guano had been applied, there would then have been some grounds for the supposition; but crops have been attacked more or less in every description of soil, with all sorts of manure, and in newly-broken up land where guano was never applied.

"Bad cultivation" and "exhausted vitality," without the aid of some specific cause, are obviously not adequate to account for the sudden and universal prevalence of this disease of the potato in two quarters of the globe.

An opinion very generally prevails, that the disease is caused by miasmata, or some unknown atmospheric influence. But it would be as easy a matter to prove that it was owing to moonshine or fairies. There is nothing solid to build upon; here, all is little else than conjecture. The various facts which have been supposed to favour such a notion, admit of a better explanation. And can it be considered probable, that any such influence should prevail in St. Helena, five or six years in succession; and that there should be no record of a similar calamity having before occurred, not only in St. Helena but throughout Europe and North America, and that one plant only should be so seriously affected? I know that it has been said repeatedly, that other plants are affected as well as the potato, and in a similar manner. This is easily accounted for; when the Cholera Morbus was raging, almost every case of sickness was attributed to it; so it is in the hue and cry about the potato disease. One man finds some of his onions decaying, the lettuces of a second droop, the kidney beans of a third are amiss, and

* Quart. Jour. of Ag. 1846, p. 388.

so the catalogue might be extended; and on these isolated facts observed in their specks of garden ground, and as if such casualities never before happened, men straightway build explanations, and raise objections to conclusions based on a review of the past history of the potato, and on the broad facts observed regarding the present disease throughout the continents of Europe and America.

The partial rotting of turnips in various localities seemed, however, to afford to the advocates of the atmospheric theory, more substantial ground to fight upon; and paragraph after paragraph appeared in the newspapers, headed, "Disease in the Turnip Crop." But the partial rotting of turnips, farmers know well is an ordinary occurrence, arising from a variety of causes; while this universal and destructive attack on the potato is a thing unprecedented not only in that crop but in all others. A similar cry was raised about the turnips in 1845, and with how much reason the editor of the Quarterly Journal of Agriculture affords the decisive answer I have previously quoted. In the last season, when the bright dry days, with calm foggy nights, of a part of August which interfered with the healthy progress of the plants, were succeeded by showery weather, all apprehension for the safety of the turnip crop vanished.

Celery plants have also been observed, in many instances, with brown blotches on their leaves, and as these appeared about the same time as the brown blotches on the leaves of the potato, it was inferred that they were both owing to the same cause, and that the cause must be atmospheric. But the partial destruction of the leaves of celery, is likewise nothing unusual, and so far from its being the result of some mysterious atmospheric influence, it is well known to be the work of a mining insect (Tephritis Onopordinis), whose larvæ live within the leaf, feeding upon the parenchyma, and thereby causing the death of the cuticle where they have fed.

Obviously the atmospheric theory cannot derive any support from the evidence afforded by other plants. If any atmospheric influence has caused the potato blight, it must be some mysterious influence injurious to that plant only; and even this supposition is evidently untenable, when we consider that in several countries where the disease was previously unknown, it originated or broke out exclusively in crops which had been raised from seed-tubers of English or American growth. A fact which seems to indicate that some agent which man can convey from one country to another, is the cause of this disease, and that the germs of this destructive influence, in these instances at least, were pre-existent in the tubers previously to planting. If none of the above mentioned influences are adequate to account for the blight, can fungi be the cause of it? All competent observers seem to coincide

in the Commissioner's observation, that "the spawn of fungi is present in large quantities in diseased potatoes." But there is much difference of opinion, as to whether fungi are a consequence or the cause of the disease. Many assert that fungi have not the power to destroy plants; and even well-informed men, certainly not botanists, but men having some pretensions to scientific knowledge, have said that fungi prey upon decaying matter only, and therefore it is to them incomprehensible how they could possibly cause the disease. But instead of proving the fungal theory to be erroneous by such statements, they only prove their own ignorance of facts of every day occurrence, for no truth can be better established, than that some species of fungi do attack plants before there has been any visible appearance of decay. They spring from the living tissue and destroy it, and it is very doubtful whether the species, which are true parasites, can live on decayed matter. It might be presumed, then, that the most simple and straight-forward mode of settling this question, would be at once to determine the habits of the fungus which is observed on the diseased leaves of the potato plant. Determine the habits of the fungus, and you determine whether it is a consequence or the cause of the disease.

In August 1845, two distinguished botanists, Professor Morren, of Belgium, and the Rev. M. J. Berkeley concluded that the potato disease was caused by a parasitical fungus (Botrytis infestans). Professor Morren for *several days* followed the progress of the disease in many potato fields, and made the following observations. "A part of the *green* tissue loses its colour and turns yellow, and the next or two days after, the spots have turned yellow, the formation of a white down (the fructification of the fungus) is perceived on the underside of the leaf. After the Botrytis has made its appearance, the stem is affected. Here and there the epidermis turns black, and the infection soon descends into the tubers." Mr. Berkeley stated, as the result of his field observations, in "*every case* I find Botrytis infestans *preceding the work of destruction*; it appears while the leaves are yet *green*, or yellowish green, and the parts attacked soon become brown and withered."

With evidence like this on record, by gentlemen qualified to observe with accuracy in matters where fungi are concerned, and supported as their observations are by the testimony of other eminent, scientific and practical men in this and other countries, one might have supposed that the question as to the immediate cause of the malady was settled. Several objections, however, have been raised to this view of the disease. M. Decaisne is reported to have said, that in order to produce the disease of 1845, the fungus must have attacked every plant, and whole fields

in an unhealthy condition have been examined, without perceiving the least trace of it. I saw three such instances during the last summer. The first was a field of early shaws, near Crayford, in Kent; the crop had a meagre and diseased appearance, and the plants were variously affected; some were prostrate and decayed throughout their whole length; others were growing in comparative health, but the majority had decaying blotches on the stems and leaves, though after a diligent search I could not detect the fungus. I kept some of the stems in my plant box two days, but no fungus was developed round the margin of the blotches. A person who had purchased the crop, and who happened to be present, attributed its unusual condition to the heat and drought of the summer, and to the use of refuse madder from some adjoining mills, as manure. On the same day I saw a field of some later variety, near Plumstead; a plant here and there was going off in a similar manner. I visited this field about a fortnight afterwards, and the number of diseased plants had considerably increased. The other crop was by the side of the Thames, opposite Teddington; on none of the leaves of these plants could I perceive the fungus, nor could I find any tubers exhibiting the peculiar marks of the disease.

These crops were noticed in July, and up to that time I had not met with any field crop attacked by the blight; but soon afterwards I saw field after field for miles, in every stage of the disease. I have seen the parasite commencing its ravages; I have seen crops which, at the first glance, presented an uniform healthy appearance, when the lower leaves on examination were found to be attacked by the parasite. And because I have met with instances of disease not apparently caused by the fungus, am I then to conclude, despite the evidence of my own senses, and of the testimony of observers like Berkeley and Morren, that the fungus Botrytis infestans is not the immediate cause of the blight. The only conclusion that I feel justified in arriving at is, that another disease co-exists with that of the blight. The potato has indeed been affected by several distinct diseases of late years, and it is owing to the want of a knowledge of this, and to the vain attempt to find one cause which will account for all the forms of disease, that has tended so much to perplex the question.

Dr. Lindley has been one of the most decided opponents of the fungal theory; but he has never, to my knowledge, questioned the accuracy of Morren and Berkeley's opinion respecting the habits of Botrytis infestans. He endeavoured to prove, that a partial decay of the plant was induced by other causes, and that fungi, as a necessary consequence, seized upon the decaying spots, and spread into the living tissue, thereby adding to the mischief. "The evil," says Dr. Lindley, "always begins next the old set, and under-

ground,"—"by the action of cold and wet, portions of the plant died and decayed; thus was prepared, a field on which the mouldiness could establish itself,"*—obviously leaving us to infer, that the mould or fungus could not establish itself, unless there was a decayed spot. The re-appearance of the blight in the dry and sunny summer of 1846, of course effectually disposed of this explanation.

The Commissioners, in their Report of Nov. 7, assigned several reasons for doubting that fungi were the cause of the disease, and it is worthy of especial remark, that they did not, in that document, urge as an objection, that decaying blotches on the leaves precede the fungus, and that it first establishes itself on the decaying spots. But, if this objection were really well-founded, all others advanced by the Commissioners against the fungal theory would be trifling and inconclusive in the extreme, as compared with it. The theory did not appear to the Commissioners well-established; not because Botrytis infestans is a species of fungus which preys exclusively on decaying matter, and not a parasite which produces decay, but, said they, "if fungi were the original cause of the disease, it is difficult to conceive why fields of potatoes, placed very near each other, should be differently affected, or why certain varieties of the plant should be much less injured than others." But what reasoning have we here? It might just as reasonably be objected, that fungi could not be the cause of a patch of mildewed wheat, because the whole field was not attacked; and the fact that some varieties of the potato, as the "cups," which the Commissioners said had offered the greatest resistance to the disease, are known to possess greater constitutional vigour than the almost worn out "apple" variety which so signally failed, is enough to account for the different power of the parasite over different varieties.

The Commissioners were also "unable to reconcile with the theory of the disease being caused by fungi, the remarkable fact, that in its present form it is certainly of modern origin. We must assume the Botrytis to have been co-existent with the potato itself, and, therefore, we must conclude that some recent causes have come into operation favourable to its increase to the present alarming degree." One might suppose, from the nature of these objections, that fungi were some imaginary or unseen influences, whose presence and action could only be proved by a process of abstract reasoning, not by direct observation. Parasitical fungi are living bodies, visible to the sight. They were seen by Mr. Berkeley, attacking the potato plants while the foliage was yet green, speedily effecting the destruction of the part attacked, and, in every case, preceding the work of destruction.

* Gard. Chron., Sept. 6, 1845.

On reading evidence so important as this, the first questions which occur to an impartial inquirer, are,—who is the author of this evidence? was he qualified by his previous knowledge and by his opportunities to be a competent observer? and can we place implicit confidence in him as a faithful recorder of facts? The Commissioners themselves supplied the answer. They admitted that "Mr. Berkeley is a gentleman eminent above all other naturalists of the United Kingdom, in his knowledge of the habits of fungi." Why then these frivolous objections to the conclusion at which Mr. Berkeley had arrived? Why these "ifs and doubts" on a point which is capable of being decided by direct observation? If the fungus be a true parasite, and not a species which preys on decaying matter only, what does it matter whether we can understand or not why different fields or varieties of potatoes should be differently affected, or why the disease had not before been developed? If the foundation be secure, if the main fact be placed beyond dispute, which is the first thing to be considered, we may then be assured that all our doubts admit of being satisfactorily explained, and our next endeavours should be to find these explanations; to discover, if possible, what are the causes which have recently come into operation, favourable to the increase of the parasite to the present alarming degree, and not to doubt the habits and power of the parasite, simply because we cannot immediately find these explanations.

As if, however, no longer to leave any room for doubt or cavil on this point, Mr. Berkeley, in his elaborate treatise published in the Hort. Soc. Trans. for Jan. 1846, said, in language as plain and decisive as it is possible for language to be, "the decay is the consequence of the presence of the mould, and not the mould of the decay. It is not the habit of the allied species to prey upon decayed or decaying matter, but to produce decay; a fact which is of the first importance. Though so many other species have this habit, these have not." Again, "I do not know of any single instance in which any of the nearly allied species have been found in any other situation than growing from the tissues of plants. Were this ever the case, they could not have been overlooked, as their spores are so much larger than any other species of the genus. The species are, in fact, as peculiar to the living tissues of plants, as are the several species of Puccinia and Uredo, which could not exist, or, at any rate, be perfected elsewhere."

Even this did not suffice to silence objections to the fungal theory. In the brilliant summer of last year, brown blotches were again observed on the lower parts of the stems of the plants, previously to the destruction of the foliage; and on this basis Dr. Lindley again raised an explanation of the disease, similar to that which he advanced in the preceding year, and with the

same object in view; viz. to show the relation of fungi to the disease; that they are a consequence and not the cause of it. In the Gardener's Chronicle of Aug. 15, Dr. Lindley stated, as an unquestionable fact, that "the disease invariably begins as a brown decay of the bark of the stem underground, and an inch or two above the old set. To this we have never yet found an exception; all the searing and blotching of leaves are long posterior to this." In a paper in the Illustrated News of Aug. 29, which is attributed to Dr. Lindley, it is further said, "it seems as if the old tuber contained the germ of some affection, or some undiscoverable deleterious matter, which acted upon the young stem just after it began to push, and that this was by degrees communicated through the subtle tubes of the stem, and corrupted the juices of the leaves. Be this as it may, the blotches of the leaves are instantly assailed by countless myriads of the parasite." I forwarded to the English Agricultural Society several reasons for not subscribing to this explanation; but it is needless to repeat them all here. Such an explanation is obviously inconsistent with well-ascertained physiological laws. If the sap ascended by the bark, there would then have been some grounds for the supposition, that the old set contained the germ of some deleterious matter which was first communicated to the bark, thence to the leaves. But the sap rises by the alburnum, or woody part of the stem; it is then elaborated in the leaves, and returns by the bark to feed the tubers. Therefore, it should follow, that any deleterious influence contained in the old tuber would first be visible in the vessels which conveyed the sap of the tuber to the leaves, or else in the leaves themselves, and not exclusively in the bark of the stem an inch or two above the old set, after it had travelled through all other parts of the plant; and surely, the young tubers should have been first inoculated with the disease of the bark, and not the leaves and then the tubers, seeing that the sap would have to pass through the unhealthy bark to the tubers, and not to the leaves.

My observations lead me to conclude, that these underground blotches are a local affection merely, of the nature of canker, induced by the moisture, or other chemical influence in the soil, on the bark of plants in an unhealthy or susceptible condition, canker being one of the most marked and constant symptoms of declining energy in old and unhealthy fruit trees.

Many plants, raised from the seed of the berry in 1845 and in 1846, have been attacked by the parasite, yet these, from their first existence, had no immediate connection with an old tuber and its undiscoverable deleterious matter; therefore, if the bark of these plants was affected underground, it must have been owing to some cause independent of the old tuber, and if the bark was

sound, then the underground blotches cannot be said to be the foundation or origin of the disease. Having some doubts about the bark being invariably blotched on the lower part of the stem, I spent a day in examining crops in different localities to satisfy myself on this point. Many stems were obligingly pulled up for me in the Horticultural Society's Garden, and they were certainly all cankered underground. This I afterwards found was the general rule, but I observed many exceptions. I found many plants, more especially of a sort called "Regents," growing near Wandsworth, whose stems underground, with the fibrous roots, were white, and to all appearance healthy, yet the leaves of these plants were infested by the parasite. The attack on the leaves is not therefore necessarily a consequence of the underground malady. Plants were indeed forwarded to Dr. Lindley, having the parent tuber or set, as well as the lower part of the stem sound, yet the parts above ground were affected by the disease, and he was consequently led to acknowledge that this, like the explanation of the preceding year, was untenable.

Thus we find Dr. Lindley has admitted that the leaves and tubers of diseased potatoes are infested by countless myriads of the fungus; and that the gentlemen who decided Botrytis infestans to be a true parasite, is our first authority on the habits of these minute plants; that Dr. Lindley has never contended that it is a species which preys exclusively on decaying matter; that the arguments which he, as a Commissioner, urged against the fungal theory are seen to be valueless; and that his attempts to show that the fungus must be a consequence of the disease, by endeavouring to prove that a partial decay of the leaves was first induced by other causes, have decidedly failed. He, nevertheless, still seems to entertain doubts about Botrytis infestans being the cause of the disease: for we now read, "the discovery of the cause of the mischief with any certainty seems hopeless, all enquiries as to that subject ending in a negative, and the world has wisely resigned itself to its fate. 'What can't be cured must be endured,' and the potato disease belongs to that class of evils."

The question as to the immediate cause of the potato blight is obviously settled. Since the publication of the observations of Professor Morren in Belgium, M. Payen in France, Mr. Berkeley in England, and Professor Liebmann in Denmark, I never have, indeed, seen any just or reasonable grounds for doubting that a parasitical fungus was the immediate cause of destruction. Some allowance may be made for the crude notions of those objectors who had not made the economy of plants their peculiar study, but none know so well as our leading botanists, that Mr. Berkeley possessed no ordinary qualifications for an investigation of this nature. He is confessedly one of the most distinguished myco-

logists of Europe; and being, moreover, a man of leisure, and residing in the country, he had ample means for making observations; the greatest deference was therefore due to his opinions. The two rival theories, (the atmospheric and the fungal) it may also be observed, had been broached previously to the appearance of the disease in the district where Mr. Berkeley resided, so that he had the great advantage of making observations on the potato crops previous to, and on the first development of the malady.

On the 23rd of August, 1845, Dr. Lindley published an article in which he ascribed the rot to atmospheric influences, to the the cold, cloudy, and wet nature of the season. On the 26th of August Mr. Berkeley received from his friend, Dr. Montagne of Paris, some potato leaves infested with the parasite, and at that date, Mr. Berkeley wrote to Dr. Lindley apprising him of this, saying that he had inquired in every direction, and could hear of no tidings of the disease in his neighbourhood, and that his own crops were never more abundant or finer. Mr. Berkeley was evidently on the watch for the destroyer, and if the plants at that time were partially decaying in the leaves, can it be considered probable that such an unusual state of things should have escaped Mr. Berkeley's observation, more especially as his attention was now directed to that point by Dr. Lindley's remarks? A few days afterwards the disease reached Northamptonshire, and Mr. Berkeley, like Professor Morren, followed its progress in various fields. The result of his observations at that time and afterwards may be briefly summed up. He found, that the same fungus that had been forwarded to him by Dr. Montagne, from France, which Professor Morren found preying upon the plants in Belgium, and which was a species new to all of them, in every case preceded the work of destruction. It attacked the leaves when green, or yellowish green, and caused them to decay. The attack on the leaves preceded the putrefaction of the stems. The partial decay of the stems preceded the decay of the tubers, and those tubers nearest to the stem or surface of the soil were generally first tainted; and the same mould which springs from the substance of the leaves uniformly bursts forth from the tubers exactly at the very spot where the decay originates. That the mould proceeds from within, Mr. Berkeley can state from personal observation, and he believes it to be a fact that it could not establish itself on a decayed substance. The parasitical fungus Botrytis infestans is, therefore, most unquestionably, the immediate cause of the potato blight. It is, moreover, well known to be a power perfectly adequate to accomplish the effect under certain conditions; therefore, before any man attempts to supersede the fungal theory by any other explanation, it appears to me essentially requisite that he should, in the first place, satisfactorily prove that these state-

ments of Mr. Berkeley and other distinguished observers are not facts but fictions.

Having shown that there are most substantial grounds for concluding that the blight of the potato is the work of a parasitic fungus, my task now is to reconcile the doubts of the Commissioners, to explain, if possible, why the disease is certainly of modern origin, and what causes have recently come into operation favourable to the increase of the parasite to the present alarming degree. In a letter in the Morning Herald, of December 2, 1845, I asked, if Botrytis infestans has been co-existent with the potato in this country, and if there have been summers heretofore equally as cold and ungenial as that of 1845, how is it that during the two centuries the potato has been in cultivation there should be no previous record of a similar calamity? What possible cause can have recently come into operation that this fungus, or cold and wet, or both combined, should now for the first time have acquired such fearful power? If both these causes have co-existed previously, and both have been unable to effect this destruction till the last year or two, then a third condition was evidently wanting, and before we could satisfactorily account for this disease, it appeared to me indispensably requisite that we should discover what is this third cause. I then concluded that either the fungus was a recent introduction, or a gradual and progressive change has been taking place in the constitutional hardiness of successive generations of the potato plant, and that the majority of those now in cultivation possess less vitality, and are more susceptible of disease and injury from adverse influences, than had ever before been known in the history of the plant. But I did not enter into the inquiry as to whether the fungus was a recent introduction, because the question would still remain to be decided, viz., what are the conditions favourable to the growth and increase of parasitical fungi? I therefore proceeded on the grounds that the fungus had always been present, an assumption which was partly justified by the known unhealthy condition of the potato plant generally, the somewhat ungenial nature of the season, and the partial rotting of tubers in the ground during summer, which had recently been observed in different parts of the country. The further experience of the last season, and facts derived from other sources, lead me however to suspect that the parasite of the potato, Botrytis infestans, did not exist in this country previously to the autumn of 1844.

Different plants, as well as different animals, have their peculiar parasites. Some parasitical fungi will indeed prey upon many different plants, but the attack of a species is generally confined to a certain natural order of plants, or to a genus, or to two or three species of a genus; whilst some, as in animals, seem to

exist on a particular part only of one species. The parasitical fungus which attacks and mildews wheat in unfavourable situations or seasons, will not live upon turnips. That which infests the turnip will seize upon the cabbage, they being nearly allied plants; but it will not touch the potato, yet the parasites of the turnip and the potato are nearly allied.

For a plant to be affected by mildew, two things then are requisite; the presence of its peculiar parasite, and the conditions favourable to the growth of fungi. As the potato is an exotic, it is not improbable that tubers of the plant may have been originally introduced into Europe without its parasite. In the same way it may have been carried by Europeans to other countries of which it is not a native, and have consequently, until lately, remained free from the parasite in those countries also; just as the cactus opuntia might have continued in our stoves from generation to generation, free from the cochineal insect, if the insects had not been purposely introduced.

M. Boussingault stated to the Academy of Sciences of Paris, on the authority of M. Joachim Acosta, that the malady is well known in rainy years at Bogota, where the Indians live almost entirely on potatoes. The potato is said to grow wild on the table land of New Grenada, and M. Acosta believes that the disease has always been familiar to the Indians. It is probable, therefore, that the parasite has co-existed with the potato in its native country. By a note to Mr. Berkeley's treatise, I learn that Professor Morren considers that the fungus is of American origin. Mr. Berkeley also evidently inclines to the opinion that it is a recent introduction. Next to South America the disease seems to have been first developed in St. Helena, which is in the same latitude as Peru, and nearer than any other country in which the disease has subsequently been experienced. This justifies the supposition that germs of the parasite may have been conveyed by the wind to St. Helena, and there finding the conditions favourable to its growth, it increased rapidly, and freighted the air with myriads of its minute and buoyant seeds. Thence it seems to have been carried to Madeira and North America, and so has gradually progressed from country to country speedily making its presence known.

It appears to have reached England in the autumn of 1844, and to have been confined chiefly to Kent. There the premature decay of the foliage was observed, and a considerable proportion of the produce decayed. The partial rotting of the tubers in the ground which had been observed in several localities in previous years, I think I shall be able to prove, hereafter, was owing to quite a distinct disease.

The first notice we had of the blight in 1845, was from the

same locality, where it had been observed late in the autumn of the preceding year. Thence it travelled west and north, halting mid-way in Scotland; so that the crops in the extreme northern parts of Scotland were free from the pest. In 1846 it proceeded throughout the Highlands of Scotland, and on to the Zetland, Shetland, and Feroe islands.

The disease has been observed to progress in a similar manner on the continent during the last season. A correspondent of the Gardener's Chronicle writing from Bologna, says, "It is very certain that the geographical limits of the disease, as well as its intensity, have extended in this part of the world very far beyond what they were last year."* The fungus, which is the cause of the blight, is moreover a species new to systematists, and if it had been co-existent with the potato in these parts, it is hardly probable that the parasite of so common a plant should have escaped the attention of the botanists of Europe, or that it should not have attacked the potato partially in former years, instead of making such an universal onslaught as in the last two very different seasons in all situations; for whether the conditions favourable to the growth and increase of parasitic fungi be atmospheric, or an unhealthy condition of the larger plant, we have had seasons when fungi have prevailed to a considerable extent on other plants, and varieties of the potato have certainly been in a very unhealthy condition previous to the two last years, and yet it has been observed to be a plant peculiarly exempt from blights and mildews.† It seems therefore probable, if not certain, that Botrytis infestans is a recent introduction, and if so, this affords a very satisfactory solution of the remarkable fact that the disease is certainly of modern origin.

Our next inquiry is one of the greatest importance, viz., What are the conditions favourable to the growth and increase of parasitical fungi, and which have led to such an extensive and unprecedented attack, on one plant only, in so many different countries, under so many different circumstances, and in some instances during several successive years? Are they some electrical or other peculiar unknown atmospheric influences, as stated by Mr. Berkeley, or chiefly an unhealthy condition of the larger plant, as I have ventured to suggest. We shall have the surest ground for hoping successfully to subdue this evil if we can only discover the secret of its power.

After what I have previously said, respecting the great deference due to the opinions of Mr. Berkeley on the habits of fungi, it may seem somewhat inconsistent and presumptuous for

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* Gardeners' Chronicle, January 30, 1847.

† Journal of a Naturalist.

me to doubt the accuracy of his views respecting the conditions which favour the attack of the parasitic tribe. But to determine the habits of a species is a matter of simple observation; the other is a much more complex inquiry, and little attention seems hitherto to have been bestowed on it, and I am persuaded that Mr. Berkeley will readily admit that my objections are neither frivolous nor visionary, even supposing he may not be induced to accord with my views.

Fungi are essentially scavenger plants. The two tribes into which they may be divided, have separate tasks assigned to them in the grand scheme of Creation. The office of one is obviously to hasten the decay of matter which is already *decaying* and dead. The office of the other, I believe, is to hasten the death of that which is already *unhealthy* or dying. Those which flourish on dead organic matter appear only when decay has commenced, not while it is yet fresh, a fact well known to most. "Fungi," says Mr. Solly, "are only developed in those solutions which are in that state of putrefaction favourable to their growth: moreover they do not appear till the solution has acquired that state." There must, I believe be unhealthy action, possibly some slight chemical change in the fluids of superior plants, before parasitic fungi can successfully attack and destroy them. Is this view of the case then supported by facts? Is the state of the superior plant consequent on certain atmospheric or other influences, the condition requisite for the attack of the parasite, or does the growth of the parasite depend on certain atmospheric conditions only? There can be no doubt whatever that the state of the weather has considerable influence on the development and increase of parasitic fungi in ordinary cases. In moist dull seasons, crops are observed to be always more or less affected by mildew. Any sudden check in the progress of vegetation, such as is caused when hot sunny weather is succeeded by calm, dull, foggy days, or by a sudden transition from weather favourable to rapid growth to weather cold and wet, is generally considered to be the precursor of blight and favourable to the growth of fungi. Now, circumstances like these would exercise an injurious influence on the health of the larger plants; it is therefore doubtful whether it is not the state of the plant attacked, rather than any peculiar atmospheric condition which favours the growth of the parasite. Other facts seem to indicate very clearly that circumstances of soil, situation, manure, &c., predispose plants to an attack of fungi independent of atmospheric influences. Thus we read in British Husbandry, respecting the diseases of wheat: "it rarely happens that blight, rust, and mildew, are felt in sunny seasons, *except* in confined inclosures, or marshy ground, where the evening dews stagnate, and where fogs are generated." Again,

"in looking over a blighted field of wheat, we may observe that the lowest and richest parts, or where it *stands thick upon the ground*, are more affected than those which stand higher." It is also said, that "wheat which has been *recently dunged*, has been found more subject to rust and mildew, than that which has been grown upon a clean fallow." A very interesting and decided instance of the predisposing effect of an excess of manure, was casually mentioned by a writer in the Agricultural Gazette.* When speaking of the value of guano as a manure for wheat, he stated that "guano produced a good crop, and there were no symptoms of blight, excepting in the spots about three feet in diameter, where the sacks were put down, here the straw was blighted evidently from receiving an over-dose." Now all these different circumstances would tend to make the wheat plants unhealthy,—hence the attack of fungi. How can it be attributed to atmospheric influences in these cases; since wheat growing in large open fields, or on the higher parts of fields, or on clean fallows instead of on land recently dunged, or if plants growing at proper distances apart, escaped? The atmospheric conditions under which the healthy and blighted plants were growing must have been the same in most of these instances, but other conditions which affected the health of the plants attacked, were not the same; the inference therefore, is, that these latter are most likely to be the conditions which led to the attack of fungi.

The habits of these parasites did not escape the attention of Mr. Knight. He had concluded that one of the principal causes of mildew was the want of sufficient moisture in the soil, more especially if excessive humidity in the air and low temperature succeed warm bright weather. He put this opinion to the test, in the cultivation of a pea, late in the autumn, a crop which at that time of the year is very liable to be attacked by mildew, and he found that by deepening the soil and by copious watering he could prevent its appearance. Mr. Knight further states, that in a forcing-house he found it equally easy by appropriate management to introduce or prevent the appearance of mildew; "when he had kept the mould very dry, and the air in the house damp and unchanged, the plants soon became mildewed, but when the mould had been regularly and rather abundantly watered, not a vestige of the disease has appeared." The development of the fungi in these cases, also, was obviously not dependent solely on certain atmospheric conditions, but chiefly on the state of the plant, consequent on the moisture or dryness of the soil in which it was growing. Other of Mr. Knight's remarks on the Peach and other fruit trees, show that he was of opinion that an

* Agric. Gaz. Jan. 24, 1845.

unhealthy state of the larger plant is the chief cause of an attack of mildew.

The increase and injurious influence of parasitic insects are generally known to depend upon the unhealthy state of the animals on-which they prey. Mr. Knight, who paid so much attention to animals as well as to plants, could hardly fail to notice that the conditions which favoured the growth, increase, and power of the parasites of the animal and vegetable world were very similar. "The different species of minute insects," he observes, "which feed upon the bodies of our domestic cattle, are scarcely ever seen, and never injurious so long as the larger animals retain their health and vigour; but when these become reduced by famine or disease, the insects multiply with enormous rapidity, and though they are at first only symptomatic of disease, they ultimately become the chief and primary cause of its continuance. The reciprocal action of the larger plant and the mildew upon each other may be somewhat similar."* The facts I have before stated in support of this view, and the close analogy which evidently subsists on so many points between the animal and the vegetable world, justify the inference, that on this point the same law prevails in both, and that an unhealthy state of the larger plant, as well as of the larger animal, is the essential condition for the successful attack of parasites.

Professor Henslow very evidently takes this view of the question. "We may safely conclude," he observes, "that a generally healthy state of the the plant without any over-luxuriance of vegetation is most likely to secure a crop against the attack of the rust and mildew fungi, but that whatever tends to make the plant sickly, whether it be excess of heat or cold, drought or wet, sudden change of temperature, poverty of soil, over-manuring, shade, &c., must be considered a predisposing cause of the disease."†

Mr. Phillips has also concluded, from his observations on the potato disease, "that the office of parasitic fungi is not to destroy healthy vegetation, but that they appear in a particular and unhealthy condition of plants to prepare them for further changes." Many who express doubts about Botrytis infestans being the cause of the potato disease entertain, I suspect, no doubt whatever about its being a true parasite, but the attack on the potato being of such an unprecedented nature, they conclude like Mr. Phillips, that some cause must have induced unhealthy action in the potato plants, and so consider the attack of the parasite is a consequence of that predisposing cause. Nevertheless, without the action of the parasite, no such disease would have been produced.

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* Knights Phys. and Hort. Papers, p. 208

† Jour. of the Royal Ag. Soc. v. 2. p. 13.

When an animal dies it is usual to attribute its death not to the predisposing, but to the immediate or exciting cause of disease. The above evidence receives additional weight, when we consider, that on the first appearance of the potato disease, Mr. Berkeley ascribed the excessive spread of the mould, or parasite, not to any electrical or other atmospheric influences, but to a cause which was generally considered at the time to have injuriously affected the health of the potato plant. In the Gardeners' Chronicle of August 30, Mr. Berkeley observed, "the primary cause is, doubtless continued wet combined with certain peculiarities of soil;" and on the 6th of September, "It appears the decay of the tubers is produced by the same cause which affects the leaves, viz.:—by the growth of a mould whose development has been promoted by excessive wet." Again, "the development of the mould and its consequent injurious effects, depending entirely upon the season, it will, beyond doubt, be impossible to find a remedy." Previously, however, to the publication of Mr. Berkeley's treatise, many additional facts had accumulated, one of the most important of which was, that the disease had been experienced in a season very different to that of 1845, in fact, a very dry and sunny season. Mr. Berkeley's veiws were necessarily modified by these facts; he, however, still considered that the increase of the parasite was due to atmospheric influences. "The mould, indeed, would not have spread, but for peculiar atmospheric conditions favourable to its growth;" but Mr. Berkeley now adds, "what these are it may be impossible to say, but it is a fact well known to every student of the extensive tribe of fungi, that their growth and especially their numbers, depend more than all other vegetables on atmospheric influences. Even the peasant knows this to be the case with mushrooms."

Mushrooms are certainly much more abundant in some seasons than in others, but I think it must be obvious that a certain range of temperature and moisture of the soil and air, are more likely to be the conditions required for the growth of the mushroom tribe of fungi, than any electrical influences. Were it otherwise, is it likely that skilful gardeners would have such uniform success in the artificial culture of the mushroom? In preparing their mushroom beds, gardeners are careful that they shall be solid and of a certain thickness; solid, that the temperature and moisture may not be subject to sudden variations; not too thick; or the heat generated by the fermenting materials would become too high and destroy the spawn; not too thin, or the temperature would not be sufficient to cause the spawn to run. In cold, wet autumns, few mushrooms are found in the open fields, and gardeners have learned by experience that too much water, at a low temperature, kills or injures the spawn. In autumns of moderate temperature, with occasional

mild showers, and on warm dewy evenings, mushrooms generally abound, and the gardener finds his reward in imitating nature, by causing tepid water, in the shape of a Scotch mist, to fall on his beds. Again, the spawn or plant may have grown, and the conditions above ground may not be favourable to the production of the mushroom or fructification of the plant; the air may be too dry; gardeners, therefore, not unusually cover their beds with straw, not so as to exclude light, but for the sake of retaining a moist atmosphere on the surface of the bed. A tuber of the potato containing the spawn of Botrytis infestans, if placed in a drawing-room, does not willingly produce its fructification. Mr. Berkeley therefore, places the diseased tubers in a damp place, or shuts them up in a tin box, and in the course of a day or so, the surface of the infected part of the tuber becomes white with the fructification of the fungus.

It is also evident, that the growth and increase of parasitic fungi, do not depend exclusively upon certain atmospheric influences, when we consider, that in the same locality some varieties of potatoes have been attacked much sooner than others. One of the most decided instances is mentioned in the Gardeners' Chronicle.* Two or three plants of a late variety had been introduced with the manure into a plot of an early variety, and the late plants were to be seen growing vigorously in the midst of desolation, while the foliage of the early plants was destroyed and the tubers were decaying. I observed during the last summer, a plot of early shaws which were leafless, very many of the tubers having the rotten apple appearance, while the parasite had only just commenced its ravages on another variety in the same ground. If the growth and increase of fungi depend solely upon electrical or other peculiar atmospheric conditions, why was not the attack simultaneous in these cases? The plants were growing under the same circumstances, living in the same soil, breathing the same atmosphere, and whether the germs of the fungus were pre-existent in the plant, or floating in the air and found their way into the interior of the plants by the stomata or breathing pores of the leaves, it is probable that both the early and late varieties were inoculated with the germs of the parasite at the same time; but in one the conditions were favourable for its development, while in the other they were not favourable, and the difference must obviously have been owing to some internal cause, as both were subject to the same external influences.

It is a common observation, that varieties are generally attacked in proportion to the progress they have made towards maturity, as if a certain cessation of the growth of the potato plant, were

* Aug. 31, 1845.

required for the growth of the parasite. Some varieties are said to have resisted the disease altogether, owing to their great constitutional vigour, and the vitality of a plant predisposed to disease is doubtless more energetic at the commencement of its growth, than when it has nearly performed its functions, and it may on that account be enabled to resist the action of ordinary external influences in the early stages of growth, and yet be afterwards affected.

Varieties, however, are not invariably attacked at a certain stage, or when the plants have nearly perfected their tubers. As local or transitory influences predispose such plants as wheat to an attack of mildew, so the attack on a given variety of the potato may be accelerated or retarded by the influence of the adverse or favourable circumstances, to which different plants may be exposed. Thus, certain known atmospheric conditions may have hastened the attack of the parasite in some localities, not because they alone are required for its development, but because they induce unhealthy action—that slight chemical change of the fluids of the larger plant which seems to be required for the growth of the parasite. Hence, according to the vigour or controlling power of the vital principle of a plant, so we find is its power of counteracting the action of ordinary external influences, and its comparative freedom from disease. If, moreover, the growth and increase of fungi depended entirely upon external causes, can it be considered probable that the same peculiar combination of atmospheric influences should have been experienced in every latitude where the disease has prevailed, from the torrid almost to the frigid zone,—in those isolated specks on the ocean, St. Helena and Madeira, as well as throughout the broad continents of Europe and America; or that the same atmospheric conditions should continue in force during several successive years, and that one plant only should be so seriously affected?

Corn crops generally, indeed almost all our cultivated plants, are known to have their peculiar parasites. "In favourable seasons," Mr. Berkeley observes, "the fungi which infest corn are not developed; in unfavourable seasons, they spread like wild-fire." Was the last season then favourable to the growth of fungi generally, or otherwise? Were corn and other field crops universally or to any considerable extent attacked? Quite the reverse. Then comes the puzzling question,—if this universal attack on the potato be solely the result of peculiar atmospheric conditions favourable to the growth and increase of fungi, how is it that there has not been a similar extensive attack on other species of plants also, in the last two seasons? The alternatives presented by this question are these,—either the parasite of the potato requires for its rapid development certain atmospheric conditions, differ-

ing from those required by the parasites of other plants, or there must be some inherent predisposition in the potato plant which has led to this extensive attack of its parasite, and which is not the immediate and exclusive result of atmospheric influences. One acre of mildewed wheat may produce seeds of the fungi sufficient to inoculate the whole of the wheat in the United Kingdom, and why is not the whole attacked, as is the case with the potato plant? Why, but because the influence which produced a tendency to disease in the wheat plants was local, or else transitory, depending on some adverse atmospheric conditions. A favourable change takes place in the weather, consequently other plants, not already attacked, regain their vigour; hence the malady does not spread. Typhus fever is a terrible scourge to mankind; it appears occasionally, attacking individuals here and there in certain localities, and then, for want of other victims, passes away. But when the constitutional strength of a people has been reduced by scant or improper food, whole districts have been nearly depopulated by this disease. The predisposition to disease in the potato is evidently not dependent on local or transitory circumstances, as in the case of wheat; hence the malady is not local, but like the constitution of a people reduced by famine, the predisposing influence is not only inherent but general; hence the universality of the disease.

In 1845 Mr. Berkeley anticipated that the disease in the potato in future years, would be of the same limited character as that usually observed in other crops, and that in a sunny season like the last, we should probably hear little of it. On the 6th of September he observed, "the parasite does not appear to have been observed before, but there is little doubt it will now be found to be more or less prevalent in damp or ill drained spots, even in the driest years:" a remark which proves Mr. Berkeley also to have observed that circumstances of soil and situation predispose plants to an attack of fungi, although the season may not be generally favourable to their growth and increase. In the Horticultural Society's Journal, Mr. Berkeley said, "the same atmospheric conditions which have favoured the progress of the parasite are not likely to occur again; but still I fear it will be felt directly or indirectly for some time." But the required conditions, whatever they may be, *did* occur again, and the crops were attacked in dry, well-drained soils, notwithstanding the sunny nature of the season. I mention this, not merely to show that Mr. Berkeley's anticipations were not realized, but to prove that there must be something very unusual about this attack on the potato, for a gentleman of his extensive experience to be so much abroad in his calculations respecting the future progress and powers of the parasite; and that his opinion of the excessive spread of a parasite

depending entirely on certain atmospheric conditions is not adequate to account for this universal attack on the potato only, in seasons and soils so very different, and in almost every quarter of the globe.

An attack on one crop so universal, is without a parallel in the history of cultivated plants. Mr. Berkeley, indeed, says, "there is nothing unusual in the prevalence of a parasitic mould; no one wonders when the hop grounds are ravaged by their particular mildew, because the cultivation of hops is so limited; but were it as universal, and of as much importance as potatoes, the ravages would equally excite attention." But why select hops? Wheat, turnips, &c., are as universally grown as the potato, and if there had ever been a similar attack on these plants, we should have heard of it. Any one who has seen a garden of hops in blossom, may well imagine that it must be a crop peculiarly liable to the attack of fungi; the tall poles standing so near each other, with the pendent shoots of the bine stretching almost across the alleys from plant to plant, must cause a stagnation and dampness of air surrounding the plants; and by the shade of the over-hanging branches, many of the lower leaves will be liable to become sickly and out of office, conditions well suited to the attack of mildew. A variety of the hop, moreover, is propagated by extension, like the potato, that is, by divisions of the roots or branches, not annually by seeds as wheat. There may be something in this. Some varieties may be continued too long, and, consequently, become more susceptible of injury from adverse atmospheric influences than others, and therefore more liable to the attack of parasites. On referring to the chapter on hops in British husbandry, I find some observations which justify this supposition. "Hop growers," it is said, "complain that their plants die off, run out, become small, and of a bad colour." To remedy these evils an agriculturist advised that fresh varieties should be raised from seeds; and a writer who had tried the experiment said, "We write from experience, having raised very many hop plants from seeds, which are found to be much more energetic and vigorous in the growth and produce than if raised from cuttings." Again, "The hop plants raised from seed surpass those which have been raised from cuttings, their luxuriant growth enabling them to withstand the effect of blights." Now, even the hop, which is so subject to mildew, was comparatively free in the last season. Nay, so unusually abundant was the crop generally, that the duty was only exceeded by the crop of the memorable season of 1826; and a writer on the hops of East Retford observed "that the grounds were in a more flourishing condition than he ever before remembered them, and, certainly, the hops had attained a size unknown to the present generation." And yet, in a season like this, the potato is laid prostrate by mildew, in every description

of soil, and in all situations throughout the length and breadth of the United Kingdom.

We have evidently, then, good grounds for concluding that an unhealthy condition of the larger plants, induced by atmospheric or other causes, predisposes them to an attack of fungi, and that the destructive power of the parasite is proportioned to the low state of vitality or susceptibility of the plant attacked; and, as this universal attack on the potato has occurred in a season not generally favourable to the growth of parasites, I think we may safely conclude, that a predisposition to disease must have existed in the potato, which was not the immediate result of atmospheric influences. And this leads to the question, is there any evidence that potatoes generally were not in a healthy condition, previous to the appearance of the present malady?

It has been said there are no data on which to found a conclusion of this nature. At the meeting of the British Association at Southampton it was also said, "debility was supposed to exist, but no proof was given of the existence of debility, and what, it was triumphantly asked, is the proof of debility in a potato?" This betrays a lamentable want of knowledge of the previous history of the potato; and it is requisite that a man should know that history, before he can be qualified to see the question in all its bearings, give due weight to facts, or arrive at sound conclusions. Formerly the potato was considered the most certain of all crops, but it has gradually become, of all crops, one of the most precarious and troublesome. Formerly the tubers would bear almost any treatment without injury; as an old writer observed, it was "a plant, if possible, more tenacious of life than couch grass." Of late years innumerable consultations have been held, experiments made, and essays published, with a view to discover, if possible, how best the tubers can be preserved from premature decay. And yet, we are asked, "where are the proofs of debility?"

I shall prove in a subsequent chapter by, I believe, most trustworthy evidence, that the plant as a species has progressively deteriorated, that for a long time after it was introduced it continued free from any observable disease, and that the first mild form of disease "curl," and the more recent and fatal "dry rot," could not be attributed solely to any peculiarity of soil, season, or mode of culture, but were peculiar to, and therefore inherent in, certain varieties for the time being.

At a meeting of some of the members of the Highland Agricultural Society, in 1844, to discuss the cause of the dry rot disease, Mr. Stirling of Kenmure House, stated that varieties recently raised from seed were decaying; and this he very properly considered was a natural consequence of the degenerate con-

dition of the parent plants; "under these circumstances, he saw no alternative but to get a fresh supply of seed, and the sooner the better, from its native country. Unless something were done," he observed, "the potato might degenerate altogether." This was the almost prophetic warning of a highly intelligent practical man, addressed to a body of practical men; and before there was anything generally known about the blight in this country. Must there not then have been something very unusual indeed in the state of the crop of late years to justify remarks like these? The unhealthy state of the plant seemed to be such an undoubted and generally recognised fact, that the same gentleman made this statement in the Morning Herald, in 1845, "In proof that the potato has become *greatly deteriorated*, you have only to appeal to any farmer of experience and observation, and if his recollection extends over the space of forty summers, he will not fail to acknowledge that the varieties of the potato in general use, are much more delicate and liable to disease than he was in the habit of finding them twenty, or even ten years ago." Mr. Stirling's observations are amply supported by the testimony of other intelligent farmers. I need only refer to the answers received by Professor Johnston to his queries respecting the blight. I select a few.

"The potato, as I have often said, has been losing constitution for years."—Mr. D. Boosie. "The potato seems so predisposed to disease that we must cease cultivating it, unless we are more successful in treating the old varieties, or get some new and hardier varieties; we are certainly crossing nature, but in what way remains to be discovered."—Mr. W. Drummond. "For the last eight or ten years I consider the plant has been very delicate and troublesome."—Mr. R. Newton. "The potato has appeared weaker for a number of years."—Mr. J. Henderson. "The theory which gives a fungus as the proximate cause seems at present best founded, but I conceive the ultimate cause lies in a weakened and vitiated constitution."—Mr. J. Girwood. "The potato being a delicate, worn-out plant, has not been able to weather the cold and wet season. I do not think the potato in its present state is capable of standing severe drought, or protracted wet and cold."—Mr. T. P. Dods. "My opinion of the cause of the disease is, that potatoes have been long losing constitution."—Mr. E. Makins. "All theories as to the cause of the disease should proceed upon the supposition that the potato plant is in an unhealthy state, and it is well to keep this also in mind when suggesting remedies."—Mr. G. Dalziel. "I consider the cause of the disease to be a general weakness of the potato plant, caused by improper management and old age; the wet season may have hastened the disease, but the plant has been gradually deteriorating for years."—Mr Goodlet. And although innumerable observations like these have been

placed on record by practical men, who, to their honour, be it said, have had the candour and manliness to avow that the potato is in a degenerate condition, and that they may possibly have erred in the cultivation of the plant, yet, gentlemen who have taken a prominent part in the discussion on the blight, incredulously inquire, "where are the proofs of debility?"

This evidence, however, refers to the United Kingdom only, and the crops have been blighted in various parts of Europe and North America. Are there any proofs, then, of the degenerate condition of the potato in those countries also? The potatoes of Europe and North America have probably descended from the same original stock. At all events there is obviously a frequent interchange of varieties between different countries, and the various diseases which we have observed in the potato have been developed in other countries also; and not only were they precisely similar in character, but in the order of their appearance. First appeared the curl, next dry-rot and ulcers, then the blight. First, the diseased sets vegetated, producing a decrepid plant; next, many sets perished without vegetating; now, the living plant is attacked, and tubers decay before they have reached maturity.

Exactly the same observations have also been made in other countries as in this, respecting the former value of the potato, and on the gradual deterioration and degenerate condition of the plant previously to the development of the blight. Thus we read from Germany: "The success of the potato crop is generally more certain than that of any other; for, very frequently, when all other crops give only a trifling return, or even entirely fail, this noble vegetable yields a comparatively large produce. Such a source of support as the potato is of great value to the poorer inhabitants of those countries, where, before its introduction, they often had to struggle with hunger and want. However, just because we have been inattentive to the hints of nature, and have continually exposed the plants to the same old and bad system of cultivation, we have in the end come to such a crisis, that we hear from all countries the dismal intelligence that potatoes do not now, as formerly, produce good crops."*

The partial failure of sets, when planted, and the increased tendency of the tubers to decay in the pits which have been manifested of late years, are now generally admitted to be indisputable proofs of a degenerate condition. Previous to the appearance of the blight, these symptoms of inherent weakness had been observed in Russia, Norway, Sweden, Denmark, Austria, Prussia, Saxony, Bavaria, France, and other countries. From America the following is said to have been written, "America, the mother-land of the potato, now obtains seed potatoes from Germany, as

* Quart. Jour. of Agric: 1844, p. 540.

their own would vegetate no longer."* Our cup variety was found to resist the blight in Canada much better than the Canadian varieties, and this was to me a sufficient proof of the degenerate condition of the potatoes generally, in that country.

Besides the partial failure of sets, other symptoms of declining vigour have been observed. In one of the German pamphlets on the potato and its diseases, published in the Gardener's Chronicle, we are told, "During the last ten years, it has been observed that the potato has exhibited a marked change in the vital powers. For,

1. Their preservation is more difficult now than formerly, four hundred or five hundred bushels of the tubers might be laid together, and no bad results ensued; but recently, sixty or seventy bushels will speedily decay.
2. Formerly potatoes, when wounded in digging them up, healed, but now they either putrefy or become tainted.
3. It is well known, moreover, that in many places they cut off the ends of the tubers, where the buds are mostly found, and planted them as sets. Now, however, these ends most speedily run to decay.
4. Damp fields, that used to yield sound and beautiful potatoes, give now a crop of far less durability.
5. Varieties of potatoes which formerly blossomed and bore fruit, perform these functions no longer; the blossoms drop off, and no seed can be obtained. All these points have been more or less observed in many places."

Similar observations have been made in this country, and to them may be added many others, to which I shall refer hereafter.

Thus we have proofs of the gradual deterioration of the potato, and of its now degenerate condition, afforded by the progressively fatal and injurious character of its diseases, by its tendency to be injured or destroyed by the same treatment which formerly did not affect its health, and by the testimony of numerous practical men, showing that instead of being as formerly one of the most certain of crops, it has been gradually becoming one of the most uncertain. Surely, then it must be admitted that I stand on no visionary ground when I contend, that the degenerate condition of the potato generally throughout Europe and America, is not a mere assumption, but a well established indisputable fact. It can no longer be said with truth, there is no proof of the existence of debility in the potato, and I trust there will not be much need hereafter to repeat the question, "what are the proofs of debility?"

I am not, however, so sanguine as to expect that objections will entirely cease. Some will urge that their crops, when

* Quart. Jour. of Agric. of 1844, p. 540

growing, did not exhibit any perceptible want of vigour, and yet they were blighted. They will dwell on the pleasing contrast their foliage afforded during the drought of summer, with the brown parched meadows and pastures adjoining, and in some instances they will also be able to point to the produce, and ask, how tolerably abundant crops can be reconciled with a degenerate condition or susceptibility to disease? But constitutional vigour is not a thing to be estimated by weight or measure. Bulk of produce or mere size, though generally an attendant on, is not an infallible proof of inherent strength either in the animal or vegetable world. Under favourable circumstances there may be no perceptible want of vigour and health. Adverse circumstances prove the constitution. Where are there any fairer forms among women than many of those who die of Pthisis? There may be no symptoms of debility in youth visible to the non-professional eye; the predisposition to disease is nevertheless there, and only requires an exciting cause to develope it. And it would be just as wise for a mother to reject all advice, and to persist in believing that the hectic flush on the cheeks of her child was the bloom of health, and that a frame so well developed was incompatible with an innate tendency to disease, as for a man to confine his attention to the outward appearance and produce of his potato plants, to the neglect of other and more important symptoms.

Rabbits, which have had the misfortune to be made pets of, or fancies, as they are called, grow to nearly double the size of the wild animals. There is nevertheless great mortality amongst them, and the slightest disturbing cause is sufficient to make them ill. A pear tree may succeed very well as a standard in the South which is totally unfit for the North; we know not exactly why, but we learn by experience that the fact is so, and that it must be owing to some constitutional peculiarity. And so we ascertain the relative hardiness of different varieties of the potato, or of the varieties of one period as compared with those of another period, chiefly by their conduct under adverse circumstances. In a crop where many of the sets had perished by dry rot, plants might be seen growing in seeming health, and there could be no great deficiency in the produce of those which lived, or surely such varieties would not have been again planted. The low state of the vitality of varieties subject to dry rot, does not admit of doubt; yet many of these have been continued by means of various expedients to the present day.

Not only have we abundant proofs that the potato generally is in a degenerate condition, but we have evidence that varieties have been mostly injured by the blight in proportion to the symptoms of debility they had previously exhibited. I need

only refer to the facts stated in the Commissioner's Report of Nov. 7. Some varieties they observed were much less injured than others; "the Irish apple potato for instance, appears to have suffered more extensively than others. All concurrent testimony points out the Irish cup variety as that which has suffered least from the attacks of disease." Now, of the apple potato it was said, in 1834, "The apple, the king of potatoes at one time, is fast hastening to decay."* But of the cups in 1835, it was said, "The coarse kind of potato called cups never fail."† In 1837, it was observed, "the cups have not only not failed to grow, but have grown vigorously on all soils and under all circumstances. This kind shows marks of much strength of structure, as well as in growth."‡ But in 1844, it was remarked, "the oldest varieties—the rough red, and common red, are most subject to disease. The cups, one of the newest sorts, blossoms but seldom bears seeds in Scotland, it is one of the most healthy kinds, but within the last two years it has begun to fail in Ireland."§ Is it possible to arrive at any other conclusion from these facts than that this variety suffered less than most others, in consequence of its possessing greater constitutional vigour; or that if the blight had been developed ten years ago, when the cups were evidently stronger than they now are, that they would have offered still greater resistance to the disease; and therefore if we had varieties free from any hereditary taint, and possessing the hardiness which must have prevailed when neither curl nor dry rot were known, that this fungus would have been comparatively powerless, and such a wide spread calamity could not have happened? All objections to this conclusion seem to be disposed of, by the facts which I shall presently mention, proving that some new hardy and healthy varieties have now resisted the blight, though growing amidst others which were attacked. If this be so, is it not obvious that there must have been some inherent power in those varieties, something independent of soil, manure, atmospheric, or any other external influence, which enabled them to pass through the ordeal scatheless? Are we not therefore justified in concluding that all varieties which are much and generally injured by the parasite, whether they have exhibited any previous symptoms of debility or not, do not come up to the required standard of vigour and health?

Having now shown that we have most satisfactory reasons for concluding that Botrytis infestans is the immediate cause of the potato blight, that an unhealthy state of the larger plant is the

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* Irish Farm. Mag. 1834, p. 430.
† Farm. Mag. 1835. p. 179.
‡ High. Soc. Trans. 1837, p. 505.
§ Ag. Gaz. Aug. 3, 1844.

chief condition favourable to the attack of parasitic fungi, that the potato throughout Europe and America considered as a species is in a degenerate and susceptible condition, and that varieties have been injured mostly in proportion to the symptoms of debility they had previously exhibited, whilst some have remained entirely unharmed, can any thing be more obvious than that a most certain means of preventing or mitigating the effects of the blight, is by increasing the constitutional vigour and hardiness of our potato crops?

We now come to inquire, how is this to be accomplished? And here we could return a most satisfactory answer if we knew the precise causes which have led to the deterioration of the potato. Professor Johnston, when speaking in 1844 of the dry rot disease, observed, that as it was experienced all over the continent of Europe, as well as in North and South America, obviously some elementary principle was required to cure the evil. But from the attention which Professor Johnston has bestowed on the diseases of the potato, I am persuaded he will readily concede, that it is not likely any elementary principle or constituent of the soil requisite for the perfect or healthy development of the plant, is the one thing needed. Disease has been manifested on newly broken-up lands; with and without manure, and with all sorts of manure. Potatoes have, moreover, been grown in some parts of Yorkshire for the London market, on the same land upwards of twenty years in succession. We may rest assured that it is the all-important vital principle, on whose power health mainly depends, wherein the deficiency lies.

Over manuring, cutting the tubers into sets, keeping the seed tubers out of the ground during winter, have each been supposed to be the cause of the degeneracy. These, with many other causes have, doubtless, contributed to the bad health of varieties, and they may thus have hastened the deterioration of the plant as a species. The present condition of the potato is the accumulative result of not one, but several adverse influences operating through successive generations. More will be said on this point hereafter.

With a view to prevent the blight, various expedients have been proposed, according to the notion entertained of its cause. Soot, salt, lime, and Epsom salts are favourite remedies. Smoke, hot-water, carbonic acid, infinitessimal doses of the salts of copper, and arsenic, and a legion of ducks have also been suggested. If there is a prospect of any of these mitigating the disease, let them be tried. I need hardly say, that I have no faith that it will ever be effectually cured by any such means. As regards the principle of the remedy to be applied, Dr. Lindley and I agree; both consider that the best mode of eradicating the disease, or at least of

enabling our crops to resist its influence, is by renovating the health of the plant by means of improved cultivation; but we differ as to the means, and I now purpose to consider which of the two methods offers the best prospect of success.

When objecting to the views I had made public (through the medium of the *Morning Herald*) on the potato blight and its remedy, Dr. Lindley said, "we advise growers not to indulge in a vain hope that seedling potatoes will be any better than what they now have; but to adopt the practice of raising potatoes for sets upon a different principle from those which are for the table; grow the potatoes for sets in poor light land, leave them in the ground all winter, undug, or plant in autumn, or if taken up and not planted in autumn, they must be thoroughly greened and packed in sand." I, on the other hand, have contended that there is no hope for us, no perfect safety in the present varieties, and that it is only by a judicious selection of seedlings, through successive generations, with improved culture, or by the introduction of strong wild plants, that we shall ever effectually get rid of the hereditary taint, and restore our crops to their pristine state of vigour and health.

I doubt the utility of Dr. Lindley's measures, because it is obviously a law of nature, that every animal and plant shall have a limited existence, and I believe it is beyond human power to continue a variety of any plant by extension, equally healthy and vigorous for ever. The varieties we now have are in a declining or degenerate condition, and man by his ingenuity can no more impart to a decrepid old man, or to a constitutionally feeble child, the robust vigour of a healthy youth, than he can restore plants in such a condition to a perfect state of vigour and health. The greatest physiological horticulturist the world has seen, tried repeatedly, by various experiments continued upwards of fifty years, to renovate the health of aged or nearly expended varieties of potatoes and other plants, without having in any one instance succeeded; and what Andrew Knight found by repeated experiments to be impracticable, no man has yet proved by experiments to be feasible. I doubt, also, the utility of growing sets in poor light or rocky land, entirely without manure; over-manuring is certainly pernicious, but a scant supply of food is not conducive to the health of either animal or vegetable.

Dr. Lindley's method, moreover, has, according to his own showing, been fairly tried and proved to be a failure. A farmer in the Calf of Man had for several years grown potatoes specially for sets, in poor land without manure; he kept them in the ground during winter, and planted in spring. In 1845 his crops were not diseased; hence Dr. Lindley inferred that they had escaped in consequence of the peculiar treatment the seed-tubers had received.

The farther experience of the last season has, however, as Dr. Lindley confesses, conclusively proved, that this management will not keep off the blight. On the 31st of August, Mr Shepherd wrote to Dr. Lindley, saying, that the haulm of his potatoes was entirely decayed by the prevailing disease, although he could not then complain of disease of the root. It may be remarked also, that the variety which has been subject to this mode of culture during several successive years, is the healthiest variety in general use—the Irish cups.

On the other hand, we have abundant evidence afforded by the history of the potato, and various other plants, of the beneficial effects of raising new varieties from seed. Let us then persevere for a few years in raising a succession of seedlings, from seeds of the most hardy and healthy plants, which we can each season obtain. Let us asssist nature in perfecting the seeds, by the application of means likely to promote a steady, healthy, and vigorous growth of our seed-bearing plants, also by cross fertilizing the flowers, and by limiting the number of seed-berries, so that we may have each year the best possible seeds from the best plants, and we shall then be acting in conformity with the laws of nature, and our exertions will most assuredly be crowned with success. This, or the introduction of healthy wild plants, as I have from the first contended, is the only certain means of restoring our crops to their former health and usefulness.

Objections, however, have been urged against both these methods, and it may be well to notice them before I state any further reasons for concluding that my remedy will prove efficient. First, as regards the wild plant. A gentleman who had received some potatoes from the Brazils, found they were blighted when grown in this country, and thus he reasoned;—the potato is a native of South America; the Brazils are in South America, therefore, these were wild potatoes; hence, there is no help in wild plants or seedlings. Of course, he felt bound to make public so important a discovery. The potato, however, is not known to grow wild in the Brazils, nor, I believe, has it ever been found in a wild state anywhere in the eastern parts of South America. In Peru, however, the potato is certainly indigenous, and it is said tubers have been received from Peru, and the plants which they produced were attacked by the disease; but because these tubers were brought from Peru, it does not necessarily follow that they were the produce of uncultivated plants. Compare the account of the growth and produce of these plants with the description in the Horticultural Society's transactions of the growth and produce of the wild tubers planted in the Society's garden, in the year 1822; and this, I think, will be sufficient to show, that the tubers which had been received from Peru, were

much more likely to have been the produce of a cultivated variety than of the wild plant. The two tubers planted in the Horticultural Gardens, although only the size of boys' playing-marbles, produced plants so exceedingly luxuriant, that it was for some time doubtful whether they were really of the same species as the common potato. "The principal stems measured more than seven feet in length, and above six hundred tubers were gathered from the two plants."

Again; it is urged, the potato, in its native country, is subject to this disease, how can we, therefore, ascribe the attack on our crops to their degenerate condition, or how can we reasonably expect that wild plants, if re-introduced, will offer greater resistance to the blight? Now, Europeans are resident in New Grenada, and "the Indians are said to live almost entirely on potatoes, the *cultivation* of the plant continuing without intermission throughout the year." It is probable, therefore, that the potatoes alluded to by M. Acosta, are varieties cultivated by the Indians after the European fashion, and, possibly, of European origin, the tubers of the wild uncultivated plants being generally so much smaller and less palatable. Be this, however, as it may, I entertain no doubt whatever, that wild plants are attacked by the parasite, just as we see different species of wild plants affected by mildew in this country. The potato in its wild state will increase both by tubers and seeds; and the tubers of a given plant will, in the course of time, like the suckers of a wild raspberry, or the runners of a strawberry, decline in vigour; they will then become more susceptible of injury from atmospheric and other influences, and more under the power of the parasite. But, so far as the wild potato is concerned, the question is likely to be soon decided, if, indeed, it be not already settled. A wild potato plant, I learn from Mr. Smee's book, has been grown in the Apothecaries' Garden at Chelsea during ten years; two wild tubers are, also, said to have been received by the Horticultural Society in July last, and these plants, amidst this universal devastation of potato crops, were growing vigorously up to the middle of October. In their present state, however, they do not seem to be adapted for general field culture, owing to their wild luxuriance of growth, and to their tendency to produce great masses of foliage, as compared with tubers. They may prove of great value in cross-breeding with some of the best of the cultivated varieties.

And not only do I consider it probable that the plant, in a state of nature, is liable to be attacked by the parasite, but I must also express my conviction, that when the potato has been restored to the highest state of perfection which it is capable of attaining, specimens of the fungus may be found on plants in some situations, even in the most favourable seasons. I conceive it

would be mere quackery to hold out any hope, that Botrytis infestans, now that it has established itself in this country, will be entirely banished, when the general health of the potato plant is restored. We can only infer what may be the future power of the parasite over the potato, from the data afforded by other plants; and our knowledge of the causes which induce partial attacks of fungi on wheat, turnips, &c., forbid the hope that our potato crops will ever be entirely exempt from the pest. All that we are justified in expecting is this; that in the most unfavourable seasons we are likely to experience, there will be no such universal attack as in the last two years, and that, when local or transitory influences are sufficiently powerful to render certain plants unhealthy, and thus to favour the attack of the parasite, there will not be that rapid decomposition of the plants as now, but that the parasite will probably be confined chiefly to spots on the leaves. In ordinary seasons I anticipate the fungus will scarcely be noticed, and that it will cause no more apprehension for the safety of the potato crop, than the fungi which attack wheat and turnips now cause for the safety of these crops. It is essential that this should be distinctly understood and borne in mind; hasty and erroneous conclusions may thereby be prevented, as it is probable many seeming inconsistencies will hereafter be observed, which this knowledge alone will satisfactorily explain.

In the matter of regenerating the potato, by means of seedling plants, it is not only objected, that nearly all which have been recently obtained from seeds in this country are as subject to the disease as the old varieties, but other species of Solanum have been attacked also. S. laciniatum, a green-house plant, but which had been grown in the open air, near Canterbury, was observed to become diseased on one side, "therefore, no raising of potatoes from seed will prevent this noisome pestilence." A gardener in Dublin observed something amiss with the fruit of one of our British species, S. dulcamara; some of his plants belonging to other genera, also, were not in the best of health. Of course, all this was owing to the same cause which produces the potato disease, "consequently, the doctrine of the dying out of the potato falls to the ground." After reading this marvellous announcement I examined many plants of S. dulcamara, which I observed in the hedges of fields of diseased potatoes, but I never met with a trace of the parasite upon them. The other British species, S. nigrum, abounds in the extensive potato grounds near Wandsworth and Battersea, and notwithstanding decaying stems of the potato might be seen resting on the wild plants, no instance of a similar disease was manifested in any plant of this species that I have seen.

In some places the fruit, or leaves of plants of the tomato,

which is a species of Solanum, annually raised from seed, have been observed to exhibit symptoms of disease somewhat similar to that of the potato; and this Dr. Lindley said, "seemed to dispose conclusively of the notion that the potato disease is to be kept off by regeneration from seed." Now, even supposing the disease of both plants was owing to the same cause, it might be answered that the tomato is naturally a more tender plant than the potato, and that its seeds are germinated in heat. But the attack on the potato was universal; was that on the tomato co-extensive? Certainly not. In one of my visits to the Horticultural Society's Garden, when the potato plants were rapidly decaying, and the leaves almost glittering with the silvery fructification of the fungus, I directed the attention of one of the chief gardeners to plants of the tomato, and to a plant of Solanum nigrum, which were at the time growing in rude health. Dr. Lindley acknowledges that all tomatoes were not attacked in the neighbourhood of tainted potato fields, and that he had seen "beautiful samples of the fruit in the market of Boulogne, all round which place the potato crops were blighted. The French peasants had not even heard of the tomatoes being attacked."† Many weeks after the potatoes throughout the country were blighted, abundance of sound fruit of the tomato was brought to Covent Garden Market. Sir G. S. Mackenzie, and others, also observed that plants which in August produced diseased fruit, afterwards recovered and yielded perfect fruit. Therefore, if the disease of the tomato plant, observed here and there, was caused by Botrytis infestans, which is not unlikely, (but of which I have no decided proof) we may be certain that the partial attack on the tomato was induced by some local or transitory influences, which affected the health of certain plants, just as the turnip, which is annully raised from seeds, was partially attacked by its parasite, during unfavourable weather, in certain localities. If I were sure that the parasite which causes the disease of the potato, was also the cause of the disease of the tomato, I should refer to the partial and comparatively harmless attack on the one, and to the universal and virulent attack on the other; to the recovery of the tomato on the return of more favourable weather, and to the non-recovery of the potato under the same circumstances, as most satisfactory evidence in favour of my conclusion, that the degeneracy of the potato is the predisposing cause which has led to the extensive and virulent attack on that plant, and that by restoring it to health such an unprecedented calamity will probably be never again experienced.

That raising a succession of varieties from seed will prove suc-

† Gard. Chron. Sep. 26, 1846.

cessful in regenerating the potato, if faithfully carried out, the experiments of gentlemen in America, Prussia, and especially in Germany, seem already to have placed beyond dispute. But even when I had no evidence that young, healthy varieties had resisted the blight, I felt the greatest confidence that they would do so. Knowing the plant to be in a degenerate condition, I relied upon the general law by which the attack of parasites is obviously governed, being well assured that if we could only restore our crops to a perfect state of health, the parasite would be comparatively powerless.

Cultivators in America had observed that old varieties, or such as were previously in an unhealthy condition, had been most injured by the blight, whilst newer sorts, in some instances, seemed to have escaped. In the Report of the Commissioners of Patents to the American Congress, on the potato disease, one writer remarks, "I have been forcibly struck with the truth that where the potato has been attacked by the rot, it has been confined, with few exceptions, to those kinds which have been propagated longest; while those recently introduced from the natural seed, are as fair as a milk-maid's cheek." In another communication it is said, "at length the evil was discovered to be the continual replanting of the same seed. Like all other plants the potato finally degenerates and runs out. The Nova Scotians now plant the berries, and thus procure new seeds, which during the second year arrives at maturity and full size. Seed thus procured is proof against the rot; and by this practice they were enabled to supply seed to our New England farmers for last spring planting." In the Morning Herald of December 26, 1846, is a letter on the renovation of the potato, copied from the Buffalo Commercial Advertiser. In consequence of the gradual deterioration and diseased condition of the potato, the Rev. N. S. Smith of that city, commenced, four years ago, to raise potatoes from seeds of the berry. The first seedlings produced very small tubers, but these when planted in the following year, afforded tubers of a large size. The berries of these plants were saved, and the seeds sown, and the produce of tubers was more abundant and of a larger size than that of the first generation of seedlings, or of the old plants. Mr. Smith sowed the seeds of the second year's growth, and an increase in the size and quantity of the tubers was the result. "This, to my mind," says the writer, "shows clearly the process by which the potato is recovering its vital energy. Besides, the new potatoes are finer in the texture than the old, produce more, and show no signs of the potato disease, though planted in the vicinity of those affected by it, and are as hard and fine in the spring, as when put in the cellar in the fall." The evidence received from Germany on this point, is much more

detailed and satisfactory. The experiments in two or three instances at least, seem to have been conducted with considerable care and skill. The author of one paper, Von Blacha, said, "In consequence of the marked diminution in the germinating power of the potatoes in this district, I three years ago obtained seeds from sound potato berries and raised plants from them. In 1845, the produce was ninety-five sacks of perfect and good potatoes. All my potatoes were infected with the prevailing disease in a high degree, excepting the ninety-five sacks obtained from the seeds, and they were all perfectly sound." Inspector Tinzman says, "The propagation of potatoes from seed is attended with many advantages. The potatoes are thereby regenerated, their produce is increased, and the potato itself is very much improved. Since I adopted the plan of raising potatoes from seed, I have not only had abundant crops, but they have all been free from the various forms of potato disease." Mr. Isensee says, "I hold the renovation of the potato from seed, as a highly important matter. I can confirm the statement that potatoes yielded by plants grown from seed, have an especially beautiful and sound appearance, a remarkably powerful development of the root, and generally a luxuriant vegetation. I have also seen that the small and very smallest potatoes of the crop grown from seed in 1844, and which were planted in the spring of 1845, yield extraordinarily fine and sound tubers, combined with an incredible productiveness." "For four years the Oberamtmann Albert has occupied himself with endeavouring to restore the vitality of the potato by propagation from seeds. He also induced others to try the experiment, which has indeed afforded some brilliant results. The potatoes generated this way exhibit constantly a great vitality. The vegetation is much more luxuriant, and the produce of tubers more abundant. The tubers are also more durable. In fact the disease (and this more particularly applies to the dry gangrene) has not developed itself in the potatoes produced from seed."* In Prussia, owing to the proved efficacy of this remedy, the Minister of the Interior had been induced to direct the attention of farmers to the importance of raising potatoes from seed. "Owing to the dry rot, and pock-marks with which potatoes were affected, Herr Zander, a Prussian horticulturist, six years ago commenced raising potatoes from seed; he has regularly raised potatoes from seed ever since, and they have remained sound during the whole time. In 1845, when the blight spread over Europe, and attained the greatest virulence in his neighbourhood; those potatoes which he had previously raised from seed, as well as those from seeds of the preceding year, continued perfectly exempt from

* Gard. Chron., March 21, 1846.

disease. He had also given potatoes raised from seed to his friends and acquaintances, and these have continued perfectly free from the universal prevailing disease. The plants generally, were highly productive, one yielded as many as 280 tubers."* The Royal Dublin Society have published a paper stating that potatoes raised from seeds in 1846, by Mr. Gorringer of Rippoldsau, and by Mr. Ottmann of Strasburgh, were all sound, although from one third to one half of the produce of potatoes planted in the usual way in these districts, were destroyed by the prevailing disease.

Thus we have the testimony of many independent experimentalists, who state, that by persevering in raising new varieties of potatoes from seeds, they have improved the quality, and increased the quantity of the produce of their crops, and that they have obtained plants possessing such a degree of constitutional vigour that not only were they able to resist the blight, but they were free from all the various forms of disease. Yet notwithstanding these cheering proofs of success, we are still met with the desponding cry—it can't be done. One refers to the failures amongst seedlings in this country, and obstinately refuses to take into account the careless manner in which the seed was saved, or the condition of the plants from which it was obtained, or how the seedlings were reared, and altogether loses sight of the important fact, that the tenderness of constitution and liability to disease, exhibited by varieties recently obtained from seed, were the chief grounds for Mr. Stirling's conclusion previously to the appearance of the blight, that "the plant was hereditarily diseased." If we point to Germany, we are bid to remember "the wide difference between the hot dry summers of Germany, and the cool damp summers we islanders usually experience;" forgetting that the plant delights in a humid, rather than in a dry sunny climate, and that we have varieties which, under ordinary circumstances, would ripen their seeds soon after midsummer. When, again, a gentleman in these damp islands declared, that not only had the Germans succeeded in regenerating the potato by raising varieties from seed, but that he also had tried the same process with success, it was then said, "seedlings had been known to be attacked in more cases than they had escaped,"—not universally, observe, but in *more* cases than they had escaped,—"therefore, sowing the seeds could not be recommended."

By raising a succession of progressively healthier and hardier seedlings, we hope gradually to substitute the robust vigour of youth for the infirmities of age; and yet, indeed, because all the progeny of tender and degenerate parents do not happen to be

* Mr. Hogan's Translation.

perfectly healthy and hardy, the practice cannot be recommended; as if it were not better to have a part healthy, than the whole diseased; and as if we could reasonably expect that the result of upwards of a century of mismanagement could be entirely obliterated by the first step in the right direction.

I wish it to be understood that I never held out any such hope as this. In my letter of Nov. 11th, 1845, I said, "in the absence of wild plants, we must use our best endeavours to re-invigorate the plant by raising new varieties from seeds of the best we have; not however to be satisfied with the first or second year's seedlings; some of these *may possibly* be better than many commonly grown, as some facts seem to indicate. But this will not do. It is only by improved culture, judicious selection, and several successive generations, that we can have any just grounds for hoping to restore the plant to its pristine vigour, if it ever can be accomplished by this means with these plants." Again, on the 2nd of December, after stating, that if reports were to be relied upon, some new varieties even then resisted the disease, I said, "but if I am right in my opinion respecting the degeneracy of the plant as a species, I must repeat my conviction that it will not do to depend upon the first or second year's seedlings, however strong they may seem to be. Successive generations of seedlings, or wild plants, will alone effectually rid us of these evils." Yet almost every writer on the potato disease, when noticing the opinion that the degenerate condition of the plant is the predisposing cause of the blight, considers it to be a sufficient answer to say, "tubers from seed, as well as tubers from sets, are diseased; consequently, this opinion is unfounded."

A similar objection was raised to Mr. Knight's views, that the disease of old varieties of fruit trees was a consequence of their age, and that younger and healthy varieties, should be obtained to supply their place. Mr. Knight's answer may be of use in the present case. "It has," said he, "been urged against the conclusion that old age is the cause of debility and decay of those varieties of fruit which have been very long cultivated, that many of the seedling offspring of such varieties are as much diseased as their parents; and it is contended that the failure of our best old varieties of fruit has arisen from a succession of unfavourable seasons. The fact that many of the seedling offspring of old diseased varieties of fruit are as much diseased as the parents from which they spring, is unquestionable; but this I conceive proves nothing more, than that diseases are hereditary in the vegetable as they are in the animal world; and it is scarcely reasonable to expect, that healthy and robust offspring can be obtained from parents, whose lives have been extended beyond their natural periods by preternatural means, and whose bodies are yearly falling

to pieces under the operation of disease, and in which the whole of the circulating fluids are in a morbid state."*

But what need of any lengthened remarks on this point? My plan for renovating the health of the potato crop has been tried, and proved to be successful. The plan which was to supersede that which I ventured to recommend has been tried also, and not only has its author acknowledged that it is proved to be a failure; but he had on two separate occasions but a short time previously to the publication of my first letter on the potato disease, placed on record the most decided opinion respecting the importance of raising new varieties of potatoes from seed—favouring a practice he has latterly been so eager to condemn.

On the 20th of December 1845, when objecting to my conclusions, Dr. Lindley said, "we regard the notion that the races of plants wear out as utterly baseless and visionary. The health of the potato is not with any certainty to be increased by raising new varieties from seeds. The idea of renovating the potato crops of Europe by raising new varieties from seed is a dream. We advise growers not to indulge in a vain hope that seedling varieties will be any better than what they now have." All this might have been passed by, if (now that the conclusion which Dr. Lindley arrived at respecting the cause of the disease is proved to be erroneous, and his remedial measures inefficient,) he had ceased his opposition to advice which was at first seemingly objectionable, because it was founded on a view of the nature of the disease different to that which he himself entertained. While, however, confessing that his mode of renovating the potato as practised in the Calf of Man, will not keep off the blight, and knowing at the same time that gentlemen in Germany, not one only, but several, have proved that new varieties have continued healthy, he yet persisted in saying that "he believed the practice he recommended to be the right one, and the most rational plan of management yet promulgated." And so late as the 2nd of January last, he advised the readers of the Gardeners' Chronicle to "have nothing to do with seedlings, and the dreams of enthusiasts, who imagine potato seed capable of working miracles. It will do no more," said he, "than potato sets, and perhaps less." Under these circumstances, it is requisite that attention should be directed to Dr. Lindley's former and unbiassed opinions respecting the wearing out of varieties of potatoes, and on the beneficial results to be expected by raising new varieties from seed. On the 6th of September, 1845, he said, "raising seedling potatoes is a practice upon the importance of which we have frequently insisted. All old varieties of those cultivated plants

* Hort. Soc. Trans., 1826.

which are propagated by division of the stem, and not by seed, seem to become feeble as they grow old, there being some analogy in this respect between plants and animals." In the Gardeners' Chronicle of March, 1st 1845, Dr. Lindley, in an article on the potato, said, "finally, let us point to the *immense importance* of renewing the vigour of potatoes by raising new varieties from seeds; this has been tried over and over again, and always with some advantage, sometimes with a great deal. It is certain that the productive quality of a given variety of the potato is in proportion to its youth, and that all varieties cease after a few years to be as productive as they once were. When Mr. Knight's seedlings were originally tried, they yielded in one case at the rate of sixty-eight and seventy for one; no such crops can now be obtained from them."

If now in March and September, it was *certain* that in the course of time the produce of varieties diminishes and they become feeble as they grow old, what had occurred since; what new light had there been thrown on the subject, that these opinions should in December be denounced as "utterly baseless and visionary?" If in March and September renewing the vigour of potatoes by raising new varieties from seeds, was a point of immense importance, a practice always attended with some advantage; why in December should the idea of renovating the health of the potato crop by new varieties from seed be pronounced a dream, and the hope that seedlings would be any better than those we now have, be dismissed as vain?

Leaving each one to answer these questions for himself, I proceed to consider, what may be our future prospects regarding the potato crop; what the most likely means for mitigating the effects of the disease on the varieties now in use; and what the best mode of raising varieties from seed, with a view to the speedy regeneration of the potato.

Many consider that the cause of the blight will, after a time, pass away as suddenly as it appeared; but I have not seen any satisfactory reasons for arriving at this conclusion. If the growth and increase of the parasite depended entirely on certain peculiar atmospheric influences, we might reasonably expect that the disease, at least in its present virulent form, would be of a transitory nature. But if the chief condition required for a successful attack of parasitical fungi is an unhealthy state of the larger plant, then it is probable that so long as any of the present degenerate varieties of the potato are cultivated, so long will the parasite continue its ravages. Obviously there is little or no prospect of Botrytis infestans ever disappearing from this country. It is probable that germs of it now exist even in potatoes which are to all appearance sound—that these germs may remain

dormant during winter—be absorbed with the the sap of the tuber by the young plant in spring—and so continue present in the plant, like a seed in the soil, till certain conditions arise favourable to their growth. Mr. Berkeley has observed young plants of the mould springing from within the cells of a potato. The germs of these could not have immediately vegetated on entering the plants, but were probably carried by the elaborated sap of the leaves, and deposited along with it in the cellular tissue. Mr. Berkeley further states, that "it seems to him most certain, from observation of those fungi which grow from the tissues of plants, that minute particles, too small to be distinguished by the highest powers of the microscope, must be carried about with the juices, and when fitting circumstances concur, proceed to act upon the tissue with which they are in contact." So early as January in the present year, when no field or garden crops of potatoes existed to furnish the air with seeds of the parasite, many crops in frames were blighted. In these cases, in all probability, the germs of the parasite were pre-existent in the seed-tubers. Herein, we have also a satisfactory solution of the fact which has proved fatal to many theories, viz., that at Bermuda, Oporto, at the Cape, and in Poland, the crops which were observed to be first or exclusively diseased, were those raised from seed-tubers obtained from America, or England.

If the foregoing premises are well founded, we may infer that the extent or virulence of the disease in future years, will depend partly on the nature of the season, partly on the adoption of various expedients known to be adverse to the growth of fungi, and chiefly on the progress which is made in regenerating the potato plant.

The disease may be modified by the season. A bright, breezy, showery summer, with few sudden transitions from heat to cold, will probably afford a crop the least affected by the disease. But as we cannot control the weather, or foretel the nature of future seasons, we should prepare for the worst by the use of those means which seem most likely to enable our plants to offer the greatest resistance to the action of adverse influences. The first point to be attended to is, to select those varieties for cultivation which have been proved to be the most hardy and healthy, and therefore least affected by the disease. As I advised in my first letter, in all time to come potatoes should be grown specially for sets, in order that we may have the most healthy and vigorous plants which the variety cultivated is capable of affording. A somewhat open airy situation should be selected for the seed-bed. If the land is springy or not well-drained, adopt the lazy-bed method of planting. If the land has been manured for the previous crop, and is in good condition, plant without manure. But

if the land is not in good heart, then apply, broadcast, in preference to all other manures, partially decayed leaves, or where this is not to be had, use charcoal dust, or charred peat, or a slight dressing of guano; the object being to promote a steady, healthy, and vigorous, but not over-luxuriant growth. Plant the tubers *whole*, not less than six inches deep, about eight inches from each other in the rows, and let the rows be about two feet apart. The same distance between the rows is of course not suitable for all varieties, this must be regulated by the planter's knowledge of the habits of the varieties he cultivates; the point he should aim at is, to have the whole of the ground covered by foliage during the bright days of summer, but so that the plants of one row shall not interfere with, or shade those of another. Plants grown for seed tubers must never be suffered to blossom. If a plant produces many blossoms and seeds, it will be at the expense of the tubers; that is, the sap which would be expended in support of the flowers and fruit, would contribute to the growth of the tubers if the flowers were destroyed. But that is not my reason for recommending this practice with plants grown specially for sets. Many facts observed in various kinds of plants, lead me to suspect that the production of seeds has a peculiarly exhausting effect on vitality, and I am much inclined to believe that if ever the experiment is tried, it will be found that a variety of potato which bears seeds abundantly, will maintain its health and vigour for a much longer period if the blossoms are annually destroyed, than if it is permitted to ripen its seeds each year.

The tubers intended for sets must remain in the ground during winter, in order to avoid the injurious effects of heating in pits, and the waste of the substance and energy of the tubers by the growth of premature and useless sprouts. Some experiments made last year seem to indicate that it is a matter of little consequence so far as produce is concerned, whether the general crop is planted in autumn or in spring. By planting in autumn much heavy work is disposed of, which would have to be done at a very busy time in spring. On the other hand, many farmers may not be well provided with manure in autumn, and the carting of manure during the frost of winter, will afford some employment at a time when labour is scarce, besides being carted with greater facility than in autumn. Some sets may also be injured or destroyed by certain causes during winter, and the crop would consequently not be so regular as if planted with entirely sound tubers in spring. Besides, by the spring tillage most soils would be rendered more friable, and in a better condition for the growth of the potato, than if ploughed in autumn only. For these reasons I should prefer planting the main crop in spring; never, however, later than the beginning of March.

The next enquiry is, when, and how the main crop should be planted—what soils, situations, and modes of culture are best calculated to mitigate the effects of the disease? In 1845 it was generally observed, that potatoes grown on peaty or moss soils were much less injured that in any other kind of land. In the last season the difference may not have been so decided, still the reports generally are much in favour of peaty soils, and considering the high price of comparatively good potatoes, the occupiers of such lands will probably be induced to plant them extensively. Clays and heavy wet loams are known to be least favourable to the growth of the potato, and in these soils the disease appears to have been most virulent. But the evidence respecting all soils is very contradictory, and the difference in the results observed, was probably owing in many instances, to a difference in situation, &c., rather than to any peculiar property of the soil.

That a given variety of the potato may suffer more from the blight in one situation than in another, is what might have been expected from the facts previously stated in proof of the conditions which favour the growth and increase of parasitic fungi. Many have observed that the disease was first developed, or has been most destructive, when the potatoes were growing under precisely the same circumstances which predisposed wheat plants to an attack of mildew.

Thus we read, "the disease has been worst on damp, low laying soils, although well drained, where the air could not circulate freely, by the place being surrounded by trees or high hedges."* "I have uniformly found that where the circulation of air is least, there the disease has been most severely felt."† "Most farmers agree that the disease was most powerful in wet and confined situations. Facts, however, incline me to attribute the prevalence of the disease in such situations, to their confined, rather than to their wet character."‡ Then again respecting the influence of an excess of manure. "The disease has appeared most where the land was naturally rich, or highly manured, and in low situations."§ "The disease was most obvious at first on the sites of dunghills.|| "Those portions of the field on which the dung heaps had been laid were very much affected."¶ It is indeed a very general observation, that those crops which had an over-luxuriant growth of stems, the result chiefly of high manuring, were most diseased. Next to peaty soils, light loams in rather elevated

* Prof. Johnston's Pamphlet, p. 149.
† High. Soc. Trans. paper No. 57.
‡ Ibid. No. 65.
§ Ibid. No. 21.
|| Ibid. No. 59.
¶ Ibid. No. 7.

or open situations, should therefore be selected for the potato crop, and much less than the usual quantity of manure should be applied, if it would not be much more advisable to manure the previous crop instead, where practicable. It is probable that the disease may be influenced to some extent by the nature of the manure. Gross animal manures, when applied in a considerable quantity, are well known to produce in plants a tendency to decay. On the other hand, partially decayed leaves, or charred vegetable matter, are highly favourable to healthy vegetation. Thus, on recently cleared woodlands, or on newly broken up grass land, potato crops are generally abundant, and of good quality. Since the publication, in Liebig's Agricultural Chemistry, of Lucas's experiments on the growth of plants in charcoal, it has been extensively used in this country, and with considerable benefit in the culture of greenhouse plants. The interesting tribe of Orchids flourish on charred blocks of wood; and Mr. Rivers in his experience of the pot culture of the rose, finds that charred grassy turf adds greatly to the health and free flowering of his plants. Wherever such materials as these can be abundantly and cheaply obtained, there is little doubt they would contribute to the health of the potato, and thereby tend to mitigate the effects of the disease.

We may, also, by other means contribute to the health of the plants, and promote a freer circulation of air amongst them. I observed in the last season that, in very many instances, potatoes were grown in rows much too near each other. The season was peculiar. During the drought in the early part of summer, the growth of the plants was slow, and much of the ground remained uncovered with foliage, and, therefore, exposed to the sun. A great amount of heat necessarily accumulated in the soil. When rain fell, the temperature continued high; and the combined influence of the warmth and moisture of the soil and air had a forcing effect on the potato plant, and caused the haulm to grow with excessive luxuriance, so that the foliage of the plants of one row soon interfered with that of another. Whenever this happens, the plants, instead of quietly attending to the formation of tubers, become engaged in a struggle with each other, fighting, as it were, for the precious light. The invariable result is, that all are more or less injured; the stems are drawn up, the sap has further to travel in its ascent and descent; many of the lower leaves become shaded and therefore useless; the stems are also more brittle and liable to be laid, and the produce of plants so situated, whether they be potatoes or forest trees, will invariably be found deficient, as compared with crops grown at a proper distance apart.

This induced me to suggest to the Agricultural Society last

Autumn, whether there might not be some advantage gained by intermixing potatoes with other crops, instead of planting them in fields or plots by themselves as heretofore. In a cottage garden, for instance, carrots, turnips, parsnips, lettuce, onions, &c., might be grown in alternate rows with potatoes. My object being to have an intermediate row of some plant having a different habit of growth. The haulm of the potato would then be shorter and firmer, and the whole of the foliage could be exposed to the light, so that no sap would be expended in useless machinery, but all would be reproductive; and if, in addition, the potatoes are planted early in March, so that they may commence their growth with the first impulse of spring, they will obviously be in a position to make the most of the time they are suffered to grow, and, owing to a free circulation of air round the plants, and to the better health they may be expected to possess, they will, probably, offer greater resistance to the parasite than if grown in the usual way. "A vigorous but not over-luxuriant plant, and a stirring atmosphere, being," as Dr. Lindley truly observed, "the greatest enemies to mildew."

Instead of this practice, some will be inclined to plant their potatoes wider apart than usual. The same object would certainly be attained; but in most cases, and in ordinary seasons, I think it would be at a needless expense of land, and, therefore, less profitable. Besides, by adopting this mixed mode of culture, the weeds of the blighted potato fields of last season seem to assure us of this consolation, that if the potatoes are again blighted, the crops grown alternately with them will be benefited by their destruction. They will obviously have a more extensive pasture for their roots, and a greater share of light for their leaves; and if the decaying stems and leaves of the potato plants are not immediately removed, as was generally the case last season, they will furnish an extra supply of manure to the remaining crops, and the extra growth of these would, to some extent, compensate for the deficiency of the potatoes.

These, however, are merely expedients to be resorted to with a view to bolster up for a few years the present degenerate varieties; and I now purpose to consider, how we should proceed in raising a succession of progressively hardier varieties from seeds, with a view to regenerate the potato in the shortest time, and in the most effectual manner.

They who are desirous to assist in this work, but who have not now set any plants apart with a view to grow them especially for seeds, may select a few growing at the south end of the rows of their ordinary crops. Secure these plants to stakes, and compel them to blossom freely, and perfect the seeds by the means hereafter mentioned.

Whenever potato seed is required, plants should invariably be grown especially for that purpose. I should, in the first place, obtain a few middle-sized tubers of, say about four, of the most healthy and hardy varieties for the seed-bearing plants; and, as the autumn months are generally more favourable to the attack of parasitic fungi than midsummer, early and second early varieties should be preferred; because, unless we had a late variety, which had been proved to be able to resist the disease, the chances would be greater of the plants being destroyed before they had perfected their seeds, than if early or second early varieties only were used. The plants must be grown from the first in the open ground, in a situation sheltered from strong winds, yet not confined or damp, but freely exposed to the sun. Enrich the soil with decayed leaves, or chopped grassy turf; on no consideration whatever apply liquid manure, or a heavy dressing of animal manure.

In favourable seasons most late varieties will produce a crop of berries as well as tubers. Intermediate varieties generally blossom, and sometimes bear a few berries; but the earliest sorts, owing to the early formation of tubers, seldom blossom, and very rarely ripen seeds. These will obviously require different treatment. In order to obtain seeds from the early varieties, we must adopt the practice of Mr. Knight, who found that if the plants are prevented from forming tubers, an abundance of blossoms and seeds will be the result.

Having made choice of a situation, and manured the soil according to the foregoing directions, fix strong stakes in the ground about three feet apart, where each plant is to grow, then place a tuber on the surface of the newly-dug soil, and in contact with the south side of a stake, cover the tuber by a mound of earth about five inches deep. Suffer only one stem to grow, and as it advances in growth, tie it to the stake to avoid accidents from the wind, &c. When the plant is about five inches high, wash away the mound of soil by a strong current of water, till the base of the stem is visible. The fibrous roots by which the plant is nourished will have made their way into the enriched soil below the tuber, these must be disturbed as little as possible; they may be readily distinguished from the runners which generate tubers, every one of which must be destroyed. The plant will shortly make an effort to produce other runners, which must be again nipped off as soon as they are perceived; and the plant being thus foiled in its endeavours to propagate itself in this manner, will ultimately direct its energies to the production of blossoms and seeds.

I consider it advisable to fertilize the flowers of one variety with the pollen of another. Some facts seem to indicate that a result of this practice is, a more vigorous seedling than could have been

obtained from either of the parent plants without the crossing. Some who may be desirous of trying this method, may not know much about the sexual organs of plants. To such the following instructions may be of use.

Take a full blown potato flower; in the inside of it, you will find six small upright bodies, five of which are alike; these are the stamens, or male organs, which produce the yellow fertilizing dust called pollen. In the centre of the flower, and surrounded by the five stamens, is the pistil or female organ; this may be known by its light green colour, and by its differing in shape from the stamens, or, by carefully tearing away the corolla or flower leaf, and the stamens, the pistil may be still further distinguished by its being seated upon the miniature berry containing the embryo seeds.

To cross fertilize it is of course requisite that the parent plants should be in blossom at the same time. A flower intended for the female parent, should not be suffered to perfect its pollen; to prevent this, it must be carefully opened just before it naturally expands, and the five stamens must be removed by a pair of small pointed scissors, taking great care to leave the pistil uninjured. When the flower has expanded, gather perfect flowers of the variety intended for the male parent, and dust the pollen on to the pistil of the flower you have previously deprived of stamens, or shake the pollen on to a sheet of writing paper, and so scatter it on to the summit of the pistil. The best time for this operation is in the middle of a dry sunny day, and to avoid failure it should be repeated every favourable day till the flowers begin to fade; the petals of flowers having been observed to shrivel and fall, soon after the seeds were fertilized, and to retain their petals for days longer if this had not taken place.

When about four berries are set on each plant, nip off the remainder of the flowers. At this stage of growth the plant will have completed its feeding organs, and a greater quantity of sap will probably be elaborated than is required for the support of the seeds, consequently, one or two tubers may now be suffered to grow, or the plant will form them in the axils of the leaves higher up the stem. If the parasite should appear on the leaves of the seed-bearing plants; as soon as the spots are perceived dust them with the flowers of sulphur on the under side of the leaves when moist. This may possibly destroy the fungus, or otherwise stop its progress.

A Silesian agriculturist, who has succeeded in regenerating the potato by means of seedlings, takes the seeds from the berries in Autumn. Zander, who has been equally successful, objects to this practice, and advises that the seeds should be preserved in the berries in a dry place secure from frost, till the beginning of

February. It may be well to ascertain for the sake of future guidance, whether these different modes of preserving the seed exercise any influence on the vigour of the young plants. Zander's plan may prove the best, especially, if the seeds were not thoroughly ripe when the berries were gathered. When the seeds are to be extracted, crush the berries with the hand, and put them in a tub or other vessel, place them in a cellar, or some other shady place, for six or eight days; as soon as a slight fermentation is observed, wash the pulp in luke-warm water; pick out the seeds, and wash them gently in one or two other waters, till they are perfectly clean and free from pulp; then scatter them on a sheet of paper, to dry; when dry, place them loosely in small canvas bags; suspend the bags in a bed-room, or some equally temperate dry place, until the time of sowing.

About the last week of April prepare a piece of free soil for the seed-bed; the previous year's onion bed, or some plot equally well manured, and which has grown a crop equally different from the potato the preceding year, should be preferred. Sow the seeds thinly and shallow, in rows six inches apart; when the plants are four or five inches high, prepare the ground into which they are to be transplanted; apply a moderate dressing of guano, or charred vegetable matter, broadcast. If the ground is hoed into ridges, that is, if it is formed into a wavelike surface (as is sometimes done for cabbages), and the seedlings are planted in the hollows, they would to a certain extent be protected from the wind; they might be watered with greater facility if the weather should prove dry, soon after planting, and the roots would ultimately be deeper in the soil than if planted on the level surface; these advantages would more than compensate for the extra trouble. Remove the plants carefully, disturb the roots as little as possible, and select a dull moist day for transplanting. Let the rows be not less than twenty inches apart, and the plants eight inches from each other in the rows. To save after trouble, reject all plants which exhibit marked symptoms of constitutional weakness, and all which have soft prostrate stems. Carefully observe the remaining plants throughout their growth, in order that the healthiest and the best may be selected to be the parents of the seed-bearing plants in the following year. Those which exhibit the greatest hardiness, which suffer the least from adverse weather, &c., must be marked by labels; and if, in addition to this indispensable property, any possess other good points, such as rather dwarf, stout, rigid stems, good-shaped tubers, and ripen somewhat early, a preference should be given to them. The Silesian agriculturist says, "a condition, sine qua non, is, that the tubers of the seedling plants be carefully preserved during winter from becoming heated and sprouted, before they are planted." It may be well, therefore,

to leave the tubers undug until the time of planting, and as they will probably be formed nearer the surface of the soil, than the tubers of plants grown from sets, a covering of two or three inches thick of brackens, heath, furze, straw, or some such material, may be needed to preserve them from frost.

When the time for planting has again arrived, and the ground been prepared, and the stakes fixed where the seed-bearing plants are to grow, dig up the tubers of one of the marked seedlings, select two or three of the largest, and plant them at once; then raise the tubers of another of the chosen plants, select and plant as before, and so proceed till the allotted space is occupied. Manage these seed-bearing plants in all respects same as those of the preceding year. Preserve and sow the seeds, and attend to the young plants as before. Mark, again, the most perfect and healthy, whose tubers are to furnish the seed-bearing plants of the following year. And when, by persevering in this process, the main object is attained, hardiness of constitution and freedom from disease, we may then more especially endeavour to obtain varieties uniting excellence of quality, and other desirable properties, with robust health. A careful and practised experimenter will indeed have an eye to this from the beginning. He will, at the outset, consider the various points which constitute perfection in the potato, and to this ideal standard he will constantly aim. He will observe the habits of his select plants, what is the length and strength of their stems, whether the foliage is ample or scanty, if the leaves are smooth and polished, or wrinkled and rugged, what is the period of ripening, and what the quantity, quality, and shape of the tubers. He will then be in a position to aim each year with some degree of certainty at perfection, by crossing his plants, with a view that the defects of one parent shall counteract the defects of the other; I mean, he will let one be too full where the other is deficient, so that if he could take from some of the points of one parent, and add this to the same points of the other parent, a more perfect plant would be obtained than either.

Some seedlings may be raised in the first or second year possessing a considerable degree of health, and yielding tubers of good quality. It would, of course, be advisable to try such a second year, with a view to supersede some of the more worthless of the varieties now in use, but to be grown only until more perfect and hardy varieties can be obtained.

These seem to me the most likely means for the speedy restoration of the potato to a healthy condition.

If any who desire to raise plants from seeds consider the above too troublesome a process, or have doubts of succeeding in cross-breeding, &c., let them plant a few tubers of a second early

variety, deprive the plants at an early stage of growth, of some of their tubers, taking special care to limit the number of berries to three or four on each plant.

It is generally known that seeds of the apple, gooseberry, potato, &c., afford plants differing widely from their parents and from each other; but it is a question whether this is owing to a propensity of these plants, (which have been much altered from the normal condition of the species,) to sport into varieties, or whether it is due to the action of adventitious pollen conveyed by the wind or insects. Baron Hepburn, in a communication to the Board of Agriculture, stated that "he had repeatedly renewed the seed of a favourite kidney potato from the apple, and as no other potatoes in flower were growing near them, the return was pure. One year, however, he planted them in a field with other varieties, to try that mode of renovation, and the crop was mostly hybrids." I have met with two or three observations to the same effect. It is highly desirable that this should be satisfactorily determined by experiment, because if the observation is really well founded, then when once we have obtained a variety possessing a combination of good properties, it would be an easy matter, by adopting certain precautions, to continue it to an indefinite period, by occasionally renewing it from seed. We may also then anticipate, with a considerable degree of certainty, what will be the character of our seedlings in cross-breeding.

They who possess a *cool* greenhouse, and who know how to manage plants under glass so as to cause healthy and vigorous, yet short jointed stems, would probably find some advantage by forwarding their plants in pots, to be afterwards plunged in the open border, when danger from frost had passed. By this means seeds of early varieties might be ripened during the generally dry and sunny weather of June; they would also blossom before the ordinary crops of the garden, consequently it would be the experimenter's own fault if any adventitious pollen interfered with his experiments. If, however, the temperature of the greenhouse is suffered to become so high as to *force* the plants, this practice cannot be recommended, and on no account should the seeds be ripened in artificial heat.

With a view to forward the young plants, and to obtain large tubers from them in the first year, many will be induced to sow the seeds on a hot-bed; but as our aim is to increase the constitutional hardiness of the plant, this mode of raising the seedlings cannot be too strongly condemned. One of the most eminent gardeners of the present day (Mr. Paxton) says, "seeds ripened or germinated in heat will never produce such hardy plants as those matured and vegetated in the open air. This has been

abundantly corroborated in practice, and proofs of its accuracy are constantly transpiring."*

The experience of the Silesian agriculturist, acquired in his endeavours to regenerate the potato, exactly coincides with Mr. Paxton's observations. "I have," said he, "made successful attempts to obtain already in the first year perfect potatoes by sowing the seeds in a hot-bed. I prefer, however, a regular bicunial growth; if I reap a twelvemonth later, I get a *durable article*, which answers all the expectations which may be formed, and is safe from the prevalent disease."

Little remains to be said on the after culture of the potato. There are, however, two or three questions on which I may venture a few remarks, viz.: What is the best mode of applying manure to the potato crop? Whether is it advantageous or not to pluck off the flowers? And whether the tubers intended for sets should be thoroughly or partially ripened?

The usual mode of applying manure is to place it in the drills below the sets. Mr. Knight, as will be seen, did not approve of this, and advised that it should be spread upon the soil, and so ploughed in. Doubtless this is the better practice, and I am glad to find that it is gaining ground. It is certain that contact with manure has destroyed sets, of late years; and if the absorption of the juices of the manure by the sets has contributed to the bad health of the potato plant as some have supposed, these evils should be avoided in future.

A soil in a state of nature is of a nearly uniform character, but one soil differs from another in quality; and we may observe how wonderfully plants in a state of nature accommodate themselves to the circumstances in which they happen to be placed. If a seed germinates in a poor soil, the young plant may be seen acting as wisely as if it had reason or instinct to guide it; it does not aim at too much, but fashions all its organs on a moderate scale. In a rich soil there is a corresponding increase in all parts of the plant. In both there is a unity of action—an adaptation of means to a certain end. Plants being thus constituted, by placing the whole of the food immediately surrounding the young potato plant, and none in the soil beyond, we evidently practice a sort of deception upon it, we induce it to make exertions at the commencement of its growth which its after means will not enable it to carry out; therefore, as Mr. Knight observed, abundant machinery will exist with a scarcity of raw material, and the crop of tubers will naturally be found defective, comparatively, with the growth of the plants. We cause them to expend that in the formation of superfluous stems and leaves which should have been reserved for the more important production of tubers.

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* Paxton's Mag. of Botany, v. 7. p. 136.

The time will arrive when farmers will enquire how manure can be most equally diffused throughout the soil, especially for such crops as grain, in which unity of action, or equal ripening, is a point of considerable importance.

Mr. Knight advised that the flowers of potato plants should be plucked off, and he was very desirous to obtain varieties which, owing to some malformation of the floral organs, or peculiarity of habit, did not naturally blossom; because the production of blossoms and seeds must tend to diminish the weight of tubers, or they must be formed by an increased expenditure of the riches of the soil.

There can be no doubt that the crop of tubers would be increased to some extent by plucking off the blossoms as soon as they become visible. If a Dutch florist wishes to propagate a hyacinth, he adopts means to prevent its flowering, and a progeny of young bulbs is the consequence. If a tulip grower has a bulb which grows too strong, producing seven or eight petals instead of six, in order to tame it he allows it to ripen its seeds. An onion forms its bulb one year, blossoms and seeds the next, and so dies; but persist in not suffering the plant to blossom, and the formation of other bulbs will be the result. The sap which these plants would have naturally employed in the formation of seeds, is thus made to contribute to the growth of bulbs. By depriving the potato plant of its tubers we cause it to blossom and seed abundantly; obviously the same sap gives existence alike to tubers and seeds; therefore, by preventing the growth of flowers and seeds, we must add to the growth of tubers.

Many experiments have been made, from time to time, with a view to determine whether any and what benefit is to be derived from plucking off the blossoms of the potato plants, and very different results have been arrived at. Some maintaining that they have proved experimentally that it is highly beneficial to remove the flowers; others with equal confidence refer to their experiments, and contend that no advantage whatever is to be gained from the practice. Both may be perfectly right as to the result of their experiments. The difference of opinion, I conceive, arises from not taking into account the influence of certain circumstances, which must interfere with, or vary the results. The benefit or otherwise of plucking off the flowers, will depend partly upon the habits of the variety of potato, partly upon the quality of the soil, and partly upon the nature of the season. The greater the number of berries which a variety naturally produces, the greater will be the gain of removing the flower buds. Second early varieties seldom produce many seeds, consequently little or no advantage could be gained by removing the flowers of these, as compared with late varieties, which generally bear seeds abun-

dantly. The quantity of berries produced by a given late variety will also depend upon the quality of the soil. The better and more suitable the soil may be, the greater will be the health and productiveness of a plant. The reproductive powers of a plant also depend on the nature of the season. If the weather of June and July should be warm and bright, with frequent showers, we may observe that even intermediate varieties are enabled to elaborate a quantity of sap equal to the wants of tubers and seeds, and in such a season the crop of berries of a late variety would be most abundant. The greatest amount of benefit to be derived from plucking off the blossoms, will therefore obviously be from a late variety, growing in a soil and season favourable to the potato.

Much also depends on the degree of care observed in nipping off the blossoms. The plants are nearly full grown when they flower, and if many stems are broken or laid by the children employed, this must tend to neutralise the benefit of destroying the flowers.

In the Highland Soc. Trans.* it is said, that the difference in favour of plucking off the blossoms as soon as they appear, instead of allowing them to remain, was nearly one-sixth of the crop. This may be considered an extreme case; but from a late variety favourably situated, we may safely calculate on a gain of tubers of not less than one ton per acre.

Much difference of opinion exists as to whether potatoes intended for sets should be partially or thoroughly ripened. One of Dr. Lindley's conditions for renovating the health of the potato crop, is, that the seed-tubers shall be "thoroughly ripened, thoroughly organized." The chief objection which has been urged against the practice of using immature sets, is founded on the notion that it must, in the course of time, cause the plants to become unhealthy. On the other hand it is clear, that under-ripened sets have proved highly beneficial in mitigating the curl and dry-rot disease. I believe it is equally certain, that they invariably produce more vigorous and productive plants than perfectly ripe tubers of the same variety. I was first taught this lesson by some villagers who were noted for the earliness of their potatoes. For two or three successive seasons I obtained my seed-stock from them, and was always assured it was of the same early variety they grew themselves. But I could not produce my crops so early as the villagers by at least a fortnight; and being unable to account for this difference, I resolved to buy the first potatoes they brought to market having the appearance of being nearly ripe. I did so, and the tubers were so

* Vol. 10, p. 237.

immature that they shrivelled almost like prunes before the time of planting; but I found I was now enabled to grow them not only nearly as early as the villagers, but larger also; and the increased size of the tubers was doubtless a consequence of the greater vigour of the plants, afforded by these under-ripe sets.

Mr. Knight planted an early variety in July; the tubers produced were soft and watery, and unfit for food, but, as he anticipated, they afforded the best of plants; "they presented the appearance of a different variety, and afforded a more abundant crop, and larger tubers than he had ever obtained from the same variety."* But the crop was not quite so early. Mr. Knight attributed "this variation in the periods of maturity of the crops, solely to different degrees of luxuriance in the plants, and to the increased size of the tubers in the one." But I suspect the difference was not solely owing to these causes.

We see in a backward spring how impatient vegetation seems to be at the restraint which is imposed upon it, and with what rapidity and energy plants grow in such a season when the weather becomes favourable. A peach tree which Mr. Knight had grown under glass, he afterwards planted out by the side of a tree of the same variety which had always been grown in the open air. And Mr. Knight observed that the former unfolded its blossoms nine days earlier, and ripened its fruit three weeks earlier, than the latter. The forced plant commenced and finished its annual growth much earlier in the preceding year, than the plant which had been constantly grown in the open air. Its season of rest, therefore, sooner expired; it became sooner excitable in spring, and thus with the same stimulus of heat and light, it was enabled to make greater progress, and mature its fruit in less time. And so it is with potatoes. The villagers, as I afterwards learned, grew two crops in the same year; the seed-tubers they sold were from the second crop, but the sets they planted were from the first crop; and this accounts for the difference in the period of ripening. The earlier the tubers are ripened, the sooner will the produce of those tubers come to maturity in the following year.

Tubers which have been accidentally left in the ground, are observed in spring to be more crisp and juicy than those which had been raised in Autumn, and stored. And now that potatoes are to be grown specially for sets, and are to remain undug during winter, it remains to be proved by experiments whether tubers which have not been suffered to become perfectly ripe, will maintain their great superiority in vigour and produce over the thoroughly ripened tubers of the same variety. I anticipate they

* Knight's Phys. and Hort. Papers, p. 197.

will continue to afford the most vigorous plants; and that this will be more especially the case with those varieties whose tubers when perfectly ripe are of a very dry and farinaceous character. I suspect, also, that the difference between the produce of ripe and partially ripe sets, will be found to be much greater than most cultivators are aware of.

The objection on the score of under-ripe tubers tending ultimately to destroy the health of a variety, will not, of course, apply now, even if it was well founded. The general crop will be grown exclusively for consumption, and the question to be determined is simply one of immediate profit—how to obtain the greatest produce at the least expense. If it would be better for the health of a variety in the long run (and possibly it may) that the tubers should ripen each year; then it would be an easy matter to calculate what proportion of the special plants would be required to plant the next year's seed bed, and so let them ripen; and if it should be found that under-ripe tubers yield the greatest produce, it would be a very simple process to pull up the stems of the remaining plants just before the foliage changed colour.

An addition of about two ounces to the produce of each plant, amounts to about a ton per acre, and when cultivators think of this, and of what Mr. Knight has said, that soft and watery sets afforded more vigorous plants and more abundant and larger tubers than he had ever before obtained from the same variety, they must be convinced that this is an enquiry which demands their best attention. If an increase of one or two tons only could be added to the produce of an acre by this means, it would be so much clear gain—obtained without any additional expense of seed, labour, or manure. By attending to this point, by a judicious selection of varieties, by using middle sized tubers for sets, by a proper application of manure, by planting at the proper time, and at a proper depth, and by nipping off the blossoms, it is not improbable that the produce of an acre may be increased several tons. Attention to what may be considered trifles in cultivation, involving little or no additional expense, may increase, in a very considerable degree, the aggregate result.

The average produce of potatoes per acre is estimated at ten tons, some say it is only about eight tons. I need only mention in order to show how much remains to be done, that the produce of a crop grown by Mr. Knight, was pronounced by several gardeners and farmers in whose presence it was raised and weighed, to be equivalent to 34 tons, 8 cwt., 107 lbs. per statute acre. And Mr. Knight felt satisfied that still larger crops may, and will be obtained from an acre of ground. Knight's Papers, p. 335.

The limited duration of varieties of the Potato, and the progressive deterioration of the plant as a species, proved by a consideration of the curl, dry-rot, and other diseases.

The exertions which will be made to re-invigorate the potato by raising a succession of varieties from seed, will probably depend, in a great measure, upon a conviction of the truth, that a variety has only a limited existence, and that the plant, generally, is in a degenerate condition. And as so much doubt has been expressed respecting the accuracy of these views, by some writers on the blight, it may be advisable to support the evidence previously advanced in favour of them, by briefly considering the history of the potato with reference to its diseases.

I need not trouble myself or my readers with the inquiry whether Drake, or Raleigh, or Hawkins, first introduced the potato into Europe; or whether it was brought from Chili, Peru, or Virginia. It is sufficient for my purpose to know that it is now upwards of two hundred years since it was introduced into these parts. For a considerable time it seems to have been grown in botanic and other gardens as a rare and curious plant. Next we read of its being somewhat extensively known as a luxury: it was supposed to have "mighty nourishing parts, and to strengthen nature in a high degree;" a character well suited to bring it speedily into general use. It was not, however, till about the middle of the eighteenth century, that the potato was much appreciated as an article of food, and cultivated in fields to any extent. Up to this period, and, indeed, for a considerable time afterwards, the plant does not appear, so far as I can learn, to have been affected by any observable disease.

This seems to be satisfactorily proved by the remarks of several of the earlier writers on the "curl," a disease so called from the leaves curling or contracting instead of expanding. I learn from a communication to the Society of Arts, that the disease probably originated, or was first observed, in Lancashire, about the year 1764. Mr. Holt said he remembered hearing of a person about that time, who, observing a few plants which decayed, or seemed to ripen sooner than the rest of the crop, and imagining that somehow or other he had luckily obtained a new and early kind, he marked the plants with a view to cultivate them, but was much disappointed by the result of his experiment. This is the most remote period I have seen assigned for the appearance of this malady.

Baron Hepburn said,* "the curl was unknown in Scotland before the years 1778 or 1779." He first heard of it as a serious and alarming calamity in 1780, when he was told it so infested

* Com. to the Board of Ag., vol. 5, p. 254.

the crops in Cumberland, as to threaten the total exclusion of the potato from the husbandry culture of that county. Dr. Anderson observed, that "the only thing that seemed to be positively certain with regard to curl is, that it was not known in the northern parts of the country till a very few years ago, and at that time it was much less frequent in the north than in the south.*

It is evident from these observations, that curl must have been manifested to any considerable extent at least, at a comparatively recent date. Many observations might be cited to prove that this first mild form of disease could not be attributed solely to any peculiarity of soil, season, or mode of culture, but that it was peculiar to, and therefore inherent in certain varieties for the time being. But I apprehend little difference of opinion exists on this point; at all events, other facts which will be stated hereafter will leave no room for doubt.

Not only have we proofs that some varieties continued free from disease when others were affected, but we have abundant evidence in various agricultural works proving, that varieties in which no symptoms of curl were exhibited, in the earlier years of their existence, became subject to the disease after they had been some time in cultivation; the predisposing cause must, therefore, have been not only inherent, but, probably, a consequence of the declining energy or diminished vitality of aged varieties. Sir John Sinclair, in his work on the potato, said, "if continued too long they are liable to disease, as the curl." Sheriff, an eminent Scotch farmer, observed, "time or old age never fails ultimately to bring on the curled or shrivelled disorder."

If, then, the curl is a malady mostly incident to aged varieties, and not the exclusive result of any local or transitory influence, it should follow, that unless certain precautions were taken, the disease would continue to re-appear from time to time, whenever varieties through age began to decline in vigour, and were exposed to the secondary or exciting causes which may be required to produce the disease. One or two writers on the blight, (obviously little acquainted with cultivation) who fondly believe that it is solely the work of some transitory or external influence, refer to the curl in support of their notions, and say that it was a disease peculiar to the close of the last century, that it passed away, and is now only known by report. But in this they are unquestionably mistaken. The curl has never entirely disappeared. We have a succession of papers on the disease from its first appearance down to the Royal Agricultural Society's Journal for 1845. During several years after it was first developed, it was seemingly much more general, and caused greater alarm to farmers than at any subsequent period. This was doubtless owing in a great measure

* Bath Papers, vol. 4.

to the novelty of the disease, and to the want of any decisive evidence of the cause of it, or of the remedy to be applied. Such a diversity of opinions at one time prevailed, that the question seemed, as one writer observed, "to be shrouded in impenetrable mystery." A variety might curl in one soil and situation, and not in another; in the same soil the plants might be curled one year, and dbe comparatively free the next; if the seed tubers had been grown in two different localities, and then planted side by side, one lot might be curled, the other free; and even among curled plants, many might be seen, to all appearance, perfectly healthy, yet the tubers from which these sprang had been all subject to the same treatment. Such observations must have been very puzzling, and without a knowledge of the predisposing and exciting causes which induced the disease, it is not surprising that farmers should have concluded that it was owing solely to some external cause and not to any thing inherent in the plant, or that in accordance with this view they should persevere in the cultivation of their old favourite varieties, trusting that the unknown agency which was supposed to be the cause of the evil, would disappear, and leave their crops in their former healthy condition. Time, however, taught them a different lesson. Varieties in which a few plants only were at first curled became wholly affected; hence the extent and virulence of the disease at that time.

Owing to the interest which the question now excited, many little experiments were tried, and many expedients were resorted to, with a view to discover the cause of the malady, and its remedy. The Society of Arts offered a premium of £30 for an essay on the curl, and the Society acted wisely, I think, by dividing the prize between three writers, for their papers are nearly co-equal in merit, and all contain important facts. They are, indeed, remarkable papers, considering the time they were published, and the character of most essays which have been written on the subject. Almost every important observation known respecting the curl may be found in these papers.

I learn from them, that the discovery had been then made (1790) that the disease was peculiar to certain varieties, and that it might be mitigated or prevented in these, by obtaining the seed-tubers from a hilly district or mossy land. This however, proved to be efficient only for a time; thus some of the more intelligent cultivators became convinced, that the disease was hereditary and incurable; therefore, the only effectual mode of getting rid of the evil was, by discarding the affected varieties. The result was, that the younger and more healthy varieties gradually superseded those which were subject to the curl. By obeying the laws of nature they conquered. In order that gentlemen who suppose curl was owing to some local or transitory influence, may be convinced that the crops were restored to a healthy condition

towards the close of the last century, by ceasing to cultivate diseased varieties, I cite the observations on this point of two of the writers of the prize essays. Mr. Pitt said, "the curl in potatoes is doubtless owing to a degeneracy in the seed; to the particular variety being worn out. The varieties which I have known to fail by curling in this county (Staffordshire,) are three, an early, and two late varieties, in lieu of which we have many valuable sorts which have never yet curled. The rational remedy therefore unquestionably is, the raising and introducing fresh varieties, a practice which has never yet been interrupted by any difficulty." Mr. Holt, (who wrote from the neighbourhood of Liverpool) observed, "the cause of the disease, so far as I can learn, appears to be nothing more than a total degeneracy of the plant, by being worn out. This district for some years, suffered great injury from curled potatoes, but few crops of late years have failed by being much infected with this disorder, for whenever the curl has appeared in ever so small a degree, that stock has been rejected by the attentive cultivator, and new seed obtained."

Thus we have a satisfactory explanation why varieties formerly held in great estimation and extensively cultivated became extinct. Hence, also, the conclusion based on this fact, as we read in Martyn's Edition of Miller, "the circumstance of the old sorts being now almost entirely cut off by curl, renders it probable that the disease is incident to declining varieties of potatoes, as canker is to declining varieties of fruit."

About the time the curl was so prevalent in this country; it seems to have prevailed to a considerable extent on the continent also.* A reward of 1200 francs was offered in 1775 by the Royal Academy of Brussels, for the best treatise on the cause of the malady. The prize was awarded to a writer who concluded, that it was the result of a degeneracy of the plant, owing, as he supposed, to its being an exotic. He advised that new varieties should be obtained from Virginia, the potato being supposed at that time to be indigenous to that country. His advice was followed, and the remedy proved to be efficient. So the Belgian, like the British cultivators, found that the most effectual, or only certain mode of restoring their crops to health, was by substituting healthy varieties for those which were subject to the disease. And in this way matters have been conducted through successive generations. A favourite variety has been continued until it became liable to curl, or otherwise unsuited to the purposes of the cultivator, it then gradually gave place to others, which for a time were more healthy and productive.

A great amount of evidence might be advanced on this point,

* Irish Farmers' Mag. 1834, p. 430.

but from the observations now stated, I think it must be conceded that the deterioration, or constitutional change which takes place in varieties consequent chiefly on the length of time they have been in cultivation, is unquestionably the foundation, or predisposing cause of the curl. What may be the immediate or exciting cause, or how the disease is induced, is perhaps a more intricate question which may only be satisfactorily determined, or finally set at rest, when investigated experimentally by some one acquainted with the laws of vegetable life, and used to the microscope.

Many well informed men consider that curl is caused by the over-ripening of the seed-tubers, and the facts are certainly too numerous, and too well authenticated to admit of doubt, proving that the state of ripeness, or rather the dry condition of the tuber, does exercise a considerable influence on, if it is not the immediate cause, of the curl.

The authors of several of the earlier papers, for instance, observed, that when curl was rife among the crops in rich, low laying, early soils, it had never been experienced in neighbouring hilly districts, having a northern aspect, where vegetation was more backward, and where the crops had not the same chance of becoming perfectly ripe. It was also frequently observed that curled plants proceeded from large hard tubers which did not decay in the ground as usually happens. Others had noticed that small potatoes which had been thrown aside for pigs, but which were planted for the want of a sufficient number of sets of larger potatoes, produced entirely healthy smooth-leaved plants.

The writers of two or three of the essays on the curl, sent to the Manchester Agricultural Society, who had observed these facts, concluded, (and the report of the Society coincided in this conclusion,) that the large potatoes produced sickly plants, because they were unripe, but I am quite at a loss to know how they could make it appear that the large hard tubers were unripe, whilst the small tubers from the same crop were ripe; if there were any difference between the two, the large tubers having been produced first, were most likely to be first ripe.

The expedients which at various times have been resorted to with a view to prevent the disease, such as obtaining the seed-tubers from late situations, or by raising them before the haulm had naturally decayed, or by planting late in the season so that they could not have time to ripen, all indicate that the under-ripe watery tubers afford the most healthy and vigorous plants, and some security against the disease.

The influence of the dry state of the tuber in producing curl, has also been proved experimentally. Mr. Knight conceived that it originated in the preternaturally inspissated state of the sap, and he, from a number of tubers, the produce of wholly diseased

plants, carefully detached the shoots, when about three or four inches long, and planted them, and as they had now little to subsist upon except water, not a single curled leaf was produced; though more than nine-tenths of the plants which the same identical tubers subsequently produced were much diseased. In one of the papers in the Trans. of the Society of Arts, it is said, that a clergyman had tried this experiment, and with a like result.

Mr. Dickson, who concluded the origin of the curl to be debility, arising from the too great ripeness of the tubers, and from the plants having expended themselves by affording blossoms and seeds as well as tubers, proved his position by another experiment. He showed that sets taken from the waxy or least ripened end of a long kidney potato produced healthy plants, whereas those from the opposite dry end of the same tubers, did not vegetate at all, or produced curled plants. This experiment is, also, mentioned in the Trans. of the Society of Arts for 1790. Mr. Hollins had observed that there were different degrees of moisture in a large potato, most at the crown, the least at the butt end; sets from the crown produced healthy plants, those from the opposite end plants which were curled. He had further observed, that curl producing potatoes were drier both before and after boiling, and that they were boiled in less time than the tubers of healthy varieties.

There can hardly be any question, then, that curl is in some way induced by the perfectly ripe or dry state of the seed-tubers. But then it seems equally certain that the potato was formerly free from this disease, and that varieties do not become subject to it till they have been some time in cultivation. How are these seeming inconsistencies to be reconciled? Either the potato formerly, or varieties in the earlier years of their existence, never ripened their tubers, or perfect ripening alone is not sufficient to account for this disease. There must be some other undiscovered agent at work, which has power over those plants only that are the produce of ripe tubers of aged varieties; or else, in the progress of time, a structural change takes place in the tubers of a given variety, the texture must become more solid, the fluids thicker and less abundant, and, therefore, incapable of supporting healthy vegetation.

A given species of plant requires a certain range of temperature, and a certain amount of light to enable it to grow in a healthy condition. The palms of the tropics will not grow to any useful purpose in England, nor will our gooseberry bushes thrive in the tropics. An excess or a deficiency of heat and light is alike injurious; both lead to functional derangement ending in general debility. A gardener, on receiving an exotic plant new to him, would desire to know its native country, and what soils and situations it preferred in its wild state, in order that he might deter-

mine what mode of culture would be most likely to be suitable to it. But different species differ widely in their power of adapting themselves to different climates, and this the gardener can only learn by experience, aided by his knowledge of the geographical range of the plant in question. Does our knowledge, then, of the native country of the potato, and of the various climates in which it is known to be cultivated, warrant the conclusion that the curl disease is caused simply by the over-ripening of the seed-tubers? that is, (if I understand correctly what is implied,) is the amount of the heat and light of our summers greater than the plant naturally requires for its healthy growth? At the first glance the notion seems ridiculous, that a plant which is a native of the tropical regions of South America, should be over-ripened in the climate of England. Of all cultivated plants the potato is most accommodating. Seemingly, wherever man can live there it will grow. It is cultivated in every latitude, from the torrid to the frigid zone, and if it is liable to be so over-ripened in this country, as to cause it to be diseased, then what, I would ask, should be the condition of the plant when grown in the West India Islands, in the burning sands of the Cape, or under the hot and brilliant summers of the United States. The quantity and quality of the secretions of a given plant, and the solidity of its tissue, depend partly upon the amount of light and heat to which it is exposed, and if the concrete state of the sap, or the dry condition of the tuber of the potato, which gives rise to curl, was simply, or solely, the effect of over-ripening in this climate, it should follow, that the plant would be useless in the United States of America, in the West Indies, or at the Cape.

If over-ripening alone is not adequate to account for this disease, possibly, the ripe state of the tuber of an aged variety may induce a certain condition of the plant which is favourable to the attack of some animal or vegetable parasite. But I am not aware that any satisfactory evidence exists, to show that this is really the case. The stems of curled plants have, in some instances, been observed to be "marked with brown streaks or patches," or, "rusty coloured spots," but whether this is a simple decay, the result of unhealthy action, or whether it is caused by parasitical fungi, is a question which remains for the microscopic observer to determine.

It has been supposed that Aphides were the cause of the curl, and the known power of these insects in curling the leaves of plants, renders such a supposition, plausible at least. But how can we reconcile with our knowledge of the habits of Aphides the fact, that of two plants growing side by side, the produce of the two opposite ends of the same tuber, one shall be healthy and the other curled? Besides, it can hardly for a moment be considered

probable, that a man like Mr. Knight, or a practical gardener like Mr. Dickson, besides a host of others, so used to the depredations of these insects, should overlook them in their endeavours to discover the cause of the curl.

Are there any more satisfactory data for concluding that a change takes place in the tubers of a given variety, when in the course of time its vigour declines; that the tissue becomes more solid and drier, and the fluids thicker and less plentiful? Or, in other words, do the tubers of a given variety under ordinary circumstances become gradually more dry and farinaceous? In animals it is well known that a structural change does take place as age creeps on. The bones gradually become more solid and brittle, the muscles more rigid, and the fluids thicker and less abundant; and various important organs, on the due exercise of which health depends, become impaired, and incapable of performing their respective functions. The opponents of Mr. Knight's theory have relied much upon this fact when doubting the accuracy of the conclusions at which he had arrived respecting the limited duration of individual plants. An animal, say they, becomes worn out or dies of age, in consequence of a structural change in many of its most important organs; but in plants or trees there is nothing analogous to this. I suspect, however, that there is a closer analogy between plants and animals, in this respect, than has hitherto been supposed to exist. But it may be well to observe, before I proceed further, that Mr. Knight's theory does not require that I should be able to prove this. It is already supported by a host of indisputable facts, which will admit of no other satisfactory explanation. But if it can be shown that structural changes do occur in plants as well as in animals, as they become old, such an important addition to the evidence of the truth of Mr. Knight's views must decisively settle the question.

The life of an animal is marked by three distinct stages, progressive, conservative, and declining. In youth the greatest amount of food is assimilated; the body increases rapidly in size and the limbs are supple; in middle age little more food is appropriated than is required for the repair or solidifying of the frame; and in the decline of life, although fed with the choicest food, the animal gradually becomes meagre and diminishes in size. "It is certain that the productive power of a variety of the potato, is in proportion to its youth." It is certain, then, that owing to a progressive decline of the vital powers—possibly to the less efficient state of the feeding organs, the plant is unequal to the task of absorbing and assimilating the same amount of food as in its youth; herein there is a great similarity between plants and animals. I believe it is equally certain that a structural change does gradually occur in plants as well as in animals, when an individual declines in

vigour, which change cannot be attributed solely to the action of external agents.

The Editor of the Irish Farmers' Magazine, when noticing that the periods of youth vigour, and the infirmities of age, are clearly recognisable in varieties of the potato plant, said, "in a few years after a variety has been raised from seed, it arrives at its greatest degree of productiveness; then it continues annually, for a number of years, to decrease in productiveness, but to become more *valuable for food*, being *more farinaceous*, or, as it is termed, drier; afterwards it begins to lose this quality also, and rapidly to decline, until, in a few years more, it is utterly useless."* Similar observations occur in the tenth volume of the Quart. Jour. of Agric. In vigorous-growing, productive varieties of the potato, yielding at first coarse grained tubers so full of fluid sap as only to be fit for cattle, this progressive change in the quality, and, consequently, in the composition or structure of the tuber, has been frequently observed. For instance, Mr. Holt mentions a variety called the "Dabb," large, coarse, and strong flavoured, and, therefore, unsuited for the table, which became so much improved as to be no longer rejected.† Martin Doyle observed that "the lumper" is becoming every year more farinaceous and palatable."‡ Other observations to the same effect may be found in the papers on the "blight," published by the Highland Society. A similar change is known to have come over the now celebrated "cup" variety.

The quality or dry condition of the tubers of a given variety may be influenced to a certain extent by the nature of the soil and season; but the gradual alteration in the tubers of varieties as above stated, is certainly of too general and progressive a character to be the exclusive result of any external influence; it is manifestly a consequence of the declining power of the inherent principle of life.

The change from a coarse watery potato, fit only for cattle, to one so different as to be suitable for the food of man, is an event of too marked a character, to pass unnoticed, even by the most careless. Hence this change has been more particularly noticed in such varieties. But if coarse varieties of the potato are subject to this progressive change, we may rest assured that all are governed by the same law, and that the finer varieties must be similarly affected; those which from the first were comparatively dry and farinaceous, become in the course of time, and when growing under ordinary circumstances, still drier, their fluids become thicker and less abundant. If so, now it is no longer a

* Irish Farm. Mag. 1834, p. 430.
† Trans. of the Society of Arts, 1790.
‡ Doyle's Cyclopædia, p. 378.

mystery why time or old age never fails to bring on the curled and shrivelled disorder;—why, a variety in the earlier years of its existence may be healthy and then become liable to the curl. The shrivelling of the aged vegetable is identical with the shrivelling of the aged animal, and obviously arises from similar causes. Another proof of the unity of design so manifest throughout creation.

We may now see clearly why the potato may be over-ripened in England, and yet be cultivated in the tropics; why cold, wet, and cloudy seasons, adverse to the growth of the potato, may produce tubers which afford the most healthy plants; and why even a young variety may be subject to the curl, while another variety may become infirm and useless without exhibiting any marked symptoms of the disease. The necessity of preventing the perfect ripening of the seed-tubers of dry and farinaceous varieties is now also rendered still more apparent. Holt observed that "the finer kinds sooner degenerate than the coarse kinds, which are almost, if not always the most productive, and retain their vigour the longest." The cause of this, too, must be now self evident. The dry and farinaceous tuber, as Mr. Knight observed, "indicates some degree of approximation to disease:" an observation evidently well founded.

The changes induced in the character of the potato by age, seem calculated to throw fresh light on the gradual deterioration, or wearing out of trees. Trees afford, on consideration, the same evidence as potatoes, of progressive structural changes, leading to functional derangement, debility, and death.

This view of the effects of age will be further investigated, and if it should prove on further consideration to be well founded, (as I am persuaded it will,) all objections to Mr. Knight's theory respecting the limited duration of varieties of plants propagated by extension must cease. Not because this explanation was required for the perfect establishment of the theory; it rests, as I before observed, on other and independent grounds, but because of the exact and conclusive evidence it will afford of the truth of Mr. Knight's conclusions.

It may, perhaps, be well to observe, that what I have now been considering,—the infirmities of a plant produced by age, is a very different thing to that unaccountable tenderness of constitution, or susceptibility to disease, which we know may co-exist in plants and animals with comparative freedom of growth.

The curl appears to have been the only serious disease affecting the potato, which had been observed in this country till about 1832, in which year many sets perished without vegetating. From the dry, hard appearance of most of the decayed sets, the disease was called the "dry rot."

There is a great similarity in the reasons which have been

assigned by farmers for the curl and dry rot diseases, and in the expedients they have resorted to with a view to mitigate or prevent them. Circumstances of season and situation also exerted a like influence, in preventing or inducing both diseases.

Of the many causes which have been supposed to produce dry rot, the most popular seem, to be over-ripening, heating in pits, and planting late in dry sunny weather. But, as I inquired in 1836, if any such causes as these are sufficient to produce the disease, why did not the same cause produce the same effect in former times, and how was it that some varieties even then cultivated, did not fail, though all were subject to precisely the same treatment. And I think I may be excused if I feel somewhat proud of the conclusion I then arrived at, viz. "cultivators might study the question, which may they would, but I was satisfied the only satisfactory answer they could obtain to their enquiries would be—degeneracy."

There can now no longer be any question that the degenerate condition of varieties of the potato is the foundation or predisposing cause of dry rot. The Germans have so evidently settled that point, that no further evidence is needed in support of the position, than the extracts from the German Pamphlets, on the regeneration of the potato, quoted in a preceding page.

What are the immediate or exciting causes of dry rot; whether it is induced by animal, vegetable, or chemical agencies, is a question which has perhaps not yet received a perfectly satisfactory solution. And so long as we are sure of the predisposing cause, and therefore of the remedy, it may be almost superfluous to inquire further into the matter. But as various conditions are found to contribute to the destruction of the sets, and in order to show what precautions should be taken by the cultivator, and in order further to prove the susceptibility of the plant, a brief consideration of these secondary causes may not be devoid of use.

Martius, who investigated the disease known as dry rot in Germany, attributed it to the growth of a fungus; and quantities of tubers have evidently been destroyed in pits by fungi in this country of late years. By a review of the facts which had been observed respecting dry rot, I had been led to conclude in 1845, that sets were destroyed by fermentation as well as by fungi, and I still incline to the opinion that fungi are not alone the cause of sets perishing. In those cases in which the disease had been developed in pits, germs of the fungus must have pre-existed in the tubers when first stored. And as the disease was seldom manifested till the approach of spring, the germs must have remained dormant in the tubers until excited by some cause into active growth. It is probable, therefore, that they may remain

dormant in some instances till after the sets are planted, and that certain conditions may hasten their development in the soil as well as in the pits.

It is a very general observation, that if tubers of failing varieties were planted whole they did not fail.* The cut surface of sets has been dusted with lime,† or coated with lime wash,‡ or puddle,§ previously to planting, and these did not fail, though other sets not so treated failed to a considerable extent. These observations indicate that some adverse influence is exercised on the sets, at the time or soon after they are planted, and that the moist cut surface is the vulnerable part, where the attack is made.

It has further been observed, that if the drills, manure, or sets, were much exposed to the sun at the time of planting, failures were almost sure to occur.|| Sets planted at mid-day during bright sunshine were found to fail extensively as compared with others planted during the moisture of the morning.¶ Hence drying up of the sets has been considered by many to be a principal cause of dry rot. But the simple abstraction of the moisture or sap by dry air, earth, &c., is of course a mechanical force merely, which would be exercised on all varieties alike, exposed to its influence, and in former times as well as now, unless, indeed, there is a difference in the structure, or in the power of retaining the sap in the sets of failing varieties. It appeared to me much more probable, that sets in these instances were destroyed by fungi rather than by drought. Although damp weather may be most favourable to the growth of fungi, dry sunny weather, as with other plants, will be most favourable for the dispersion of their seeds; if so, there would be a greater probability of the germs of fungi being deposited upon the sets, manure, &c., in sunny than in damp weather.

When sets have been planted with fermenting manure, failures to a considerable extent have been frequently observed.** In other instances sets of a failing variety planted without manure, lived; whilst others planted with manure failed.†† Sets planted under the manure, with the cut surface on the soil lived;‡‡ as did also other sets placed with the cut surface upward, and the

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* Farm. Mag. 1835, p. 275. Jour. of Royal Ag. Soc. v. 1, p. 246.
† Gard. Chron. 1842, p. 254.
‡ Quart. Jour. of Ag. 1837, p. 500.
§ Arthur's Potato problem solved.
|| Quart. Jour. of Ag. 1837, p. 483.
¶ Ibid p. 484.
** Ibid p. 489, &c. and Farm. Mag. 1834, p. 268.
†† Farm. Mag. 1835, p. 214.
‡‡ Ibid. 1834, p. 268.

skin next to the manure,* whilst many of those planted with the cut surface on the manure perished, and were found, as it were, glued to it.

Contact of the cut surface with the manure was obviously the cause of the destruction of the sets in these cases; but how the decay was induced by the manure it may be difficult to say. It may be by stimulating into action latent germs of fungi; or by producing a cankerous decay of the sets; or by exciting fermentation. Heating in pits has hastened the development of Botrytis infestans, in tubers; and if sets planted with the skin next to the manure, or whole tubers, had not been comparatively safe from dry rot, it might have been inferred that the heat of fermenting manure, had merely produced a certain effect on the tuber, and thereby excited inert germs of fungi. Manure cankers the roots of tender plants, and the underground stems of potato plants now exhibit a disposition to canker; sets of the potato in the present degenerate state of the plant may, therefore, be destroyed by that means. The decay has been observed to commence at the cut surface. But a decay which is the result of canker or fungi, will not, I think, cause the sets to be glued as it were to the manure, and it is equally doubtful, whether the sets would so readily assume the character of wet or dry rot, according to the moisture present. These observations seem to point to fermentation.

Recently-made fermenting manure is more frequently made use of in the cultivation of the potato, than in the culture of any other agricultural plant. Vegetable matter in an active state of fermentation, has the power of inducing other vegetable matter to ferment likewise, if placed in contact with it, and this speedily, if the fresh matter has been previously deprived of life. But the matter constituting a living plant or animal is under the control of, and is peculiarly arranged and held together, by the power of the vital principle, which, in proportion to its strength, resists the force of chemical action. If tubers are planted whole, they do not, or at least did not, perish; in consequence of the skin being entire, the small quantity of fermenting manure placed in the rows has no influence on them. But the section of a tuber has a surface destitute of skin, the natural protection against disturbing influences from without. Morbid matter, which, if placed on the fresh wound of an animal would cause its death, if placed on the skin would be powerless for evil. Thus, by cutting the tubers into sets, and by planting the sets with the cut surface on the manure, we evidently place them at the greatest possible disadvantage in the trial of strength which must ensue. If the

* Farm. Mag. 1835, p. 178.

vitality of the set is strong, it will be able to counteract the disturbing influence of the chemical action to which it is opposed, and live. But if, from any cause, there is a diminution of vitality in the set, then the force of chemical affinity may prove the stronger power; vitality is then destroyed, fermentation commences, putrefaction follows, and the set becomes reduced to a mass of disorganised matter, which assumes the character of wet or dry rot, according to the soil or season. The transition from the dry to the wet rot state of the disease, has been frequently observed to occur soon after a heavy fall of rain. This favours the conclusion that sets are in some instances destroyed by fermentation, a certain amount of moisture being seemingly requisite to complete the putrefactive process. Manure itself affords an example. If a hot-bed is well made and properly moistened when put together, when fermentation has subsided, the manure is found reduced to a solid brown, unctuous mass. But if the manure was not sufficiently moist when put together, then putrefaction is to some extent arrested, the straw is imperfectly reduced, and the manure is in places, dry, dusty, and mouldy.

If, then, the primary cause of this malady is the degeneracy and diminished vitality of the potato, it must follow that every adverse influence to which the tubers may be exposed, must contribute more or less to their destruction. Thus the heating of large quantities of potatoes in pits, which in former times was comparatively harmless, destroys vitality now, or causes the sets to be more easily acted upon and destroyed by other influences when planted. Over-ripening of the seed-tubers is found to be a predisposing cause of disease in failing varieties. The ripening process is the last step to decay. Late planting is also found to be dangerous; the vital power of the tuber, or set, will diminish in proportion to its age; useless sprouts are also produced by this needless delay, and if a tuber produces long sprouts, and these are broken off previously to planting, it is so much of the energy and substance of the tuber wasted, and the young plant may be expected to grow with less vigour in consequence, or the set may be more easily destroyed.

When the constitution of an animal is impaired by disease or old age, it is more susceptible of injury from atmospheric influences and other causes, than another animal of the same kind, possessing a strong and vigorous constitution. If two such animals were placed in similar adverse trying situations, disease in the former would probably be developed, and prostration of strength or death would be the result; whilst the latter might pass the ordeal, comparatively speaking, uninjured. Thus we see what a close analogy subsists in this respect, also, between animal and vegetable life. In former times potatoes were doubtless thoroughly ripened,

stored together in great quantities; liable to ferment in pits; planted late in the season; in dry and sunny, as well as in cloudy weather; at noon day, as well as in the early morn; and with hot fermenting, as well as fermented manure; but owing to the then inherent strength of the potato these influences were comparatively powerless.; and the recently acquired power of such influences over the potato, afford the most unequivocal evidence of the degenerate condition of the plant in these latter days.

Another disease of a threatening character has recently been developed in the potato, which appears to be quite distinct from the blight, or the dry rot. It is distinguished in the tubers by small roundish, dark coloured, soft ulcers, having a similar appearance to the decaying specks on apples. I find this disease has been observed on the Continent, in England, Ireland, and Scotland; in the latter country farmers have given to it the somewhat expressive name of "small pox;" by others it is called the "ulcer" disease. I stated in 1845, on the authority of a gentleman well known to me, that potatoes had rotted to such an extent in the neighbourhood of Lancaster, two or three years previously, that cottagers began to consider it better to dispose of their manure for money, than use it for a potato crop. This I supected was owing to mild attacks of the blight; further inquiries lead me to conclude that the mischief was caused by the ulcer disease.

The malady is referred to by the writers of several of the papers on the blight in the Highland Society's Transactions; one (No. 64) has proved that it is hereditary. He planted a number of potatoes, which had "the thickest covering of these black spots" alongside of others which were free, and he states that the produce of the last was sound, but "without exception every set planted with black spots produced tubers similarly affected." The specks are observed on the tubers when taken out of the ground, and they increase in the pits. No. 117, speaks of "the dangerous disease which has appeared for many years past on the skins of the tubers in Autumn, in the form of specks or ulcers, which, by spring, extend nearly all over the tubers, forming large ulcers, and causing a total blindness of the eyes and loss of vitality."

An aggravated form of the ulcer disease seems to have been recently experienced in the neighbourhood of Florence Court, Ireland.* It is said the disease does not commence above ground, but the tubers as soon as they are formed, are attacked with dark coloured ulcerated blotches. A plant having the diseased tubers becomes languid, the leaves have a sickly yellow colour, yet the plant still exists, and forms more tubers which are also attacked. The plant becoming more and more unhealthy, most frequently

* Gard. Chron. Oct. 3, 1845.

dies a month or six weeks before the healthy plants arrive at maturity.

These are obviously not the symptoms of the blight—the appearance of the diseased tubers, the general attack of the blight, and the individual attack of the ulcer disease, the speedy destruction of the plant caused by the former, and the langour and lingering death produced by the latter, show that the two diseases are very different. It is not therefore probable that one is a modification of the other, as some have suggested. If this were the case, is it likely that the ulcer disease would have assumed so suddenly such a virulent and widely different character, or that the crops in the Highlands would be affected by ulceration in 1845, and previous years, as stated, and yet be free from the blight in 1845, when the crops of all other parts of the United Kingdom were slain by this disease.

Now, the appearance of tubers affected by dry rot, and those infested with the blight fungus, is very similar, and this has led many to suppose that several instances of the blight have occurred in years prior to 1845.* In the Highland Society's Report it is concluded, that the disease existed in Ayrshire at least in 1844. This might be so. But I would suggest, whether the disease which was observed in the produce of the two fields soon after it was stored, was not more probably caused by the dry rot fungus, than by the species which is the cause of the blight. Dry rot may be developed sooner or later by the force of circumstances. One of the fields was "richly manured with guano, farm yard manure, and other substances, and the growth of the plant was very vigorous." Now from what we know of the effects of an excess of manure, in producing a tendency to decay, and predisposing plants to an attack of fungi, this rich manuring may have been sufficient to cause an earlier vegetation of the dry rot fungus than usual.

Papers from other parts of Scotland, as well as Ayrshire, state that tubers have been observed to become diseased in the pits at different periods in former years. No. 89, writing from Kircudbrightshire, says, "the former disease (dry rot) was seldom detected in the potato until the time of planting, instances however occurred in which it showed itself at an earlier period, even at the time the potatoes were taken out of the ground." No. 67,

* The authors of one or two pamphlets on the blight, assume that it was developed in various parts of Europe about 1830; but Martius's treatise to which they refer, was on the dry rot, not on the blight. There was no decay of the plants as now, and seldom were any symptoms of disease observed in the tubers, until they had been stored some time, and most frequently not till after the sets were planted. Martius attributed the disease to a species of Fusarium, not to a Botrytis. Mr. Berkeley, who translated portions of Martius's work, said, "the blight of 1845, is altogether different from the dry rot, or any disease of the potato that has been recorded."

states that the produce of a field of three or four acres in Fifeshire, seemed to be affected with the same disease in 1842." Several other writers confound the two diseases; they say the Autumn is but a modification of the Spring disease, and that they have seen it for years. If Botrytis infestans was in Ayrshire in 1844, why were the crops in the Highlands free from the pest in 1845, and then so early and universally attacked in 1846. The chief characteristic of the blight, the general and premature destruction of the foliage, does not seem in any instance to have been observed previously to 1845, except in Kent.

I might adduce other evidence in proof of the progressive deterioration of the potato, and enumerate other diseases which have lately been observed in the crop in proof of its degenerate condition; but more than enough has already been said to convince any one willing to apprehend truth, of the susceptible condition of the potato previously to the development of the blight. I now, therefore, purpose to offer a few remarks on the probable cause of the deterioration. As it has not been suddenly but gradually produced, and not in certain localities only, but throughout various countries; we may infer that it is the result of some general adverse cause or causes operating through successive generations.

The health of a young plant depends upon that of the seed, the health of the seed depends chiefly on the health of the parent plant, and the health of the parent plant depends on the original vigour of its constitution, on its youth, and on the action of external influences. "Like will produce like," is a favourite maxim of the breeders of animals, and so far as constitutional vigour is concerned, it is equally applicable to plants. The offspring of a plant or animal, with a vigorous constitution, in the prime of life, and in perfect health, is robust and healthy; and were plants and animals never raised but from such parents, each succeeding generation would be as healthy and strong as that which preceded it. But if, from any cause, the constitution of a plant or animal has been impaired, the offspring will to some extent inherit the susceptibility of its parent. Thus, if a variety of the potato, originally healthy, is continued by sections of the tuber until it declines in vigour through age, and seeds are then saved from it, the young plants produced by these seeds would, doubtless, commence life with a less hardy and vigorous constitution than did the parent plant, or than would plants raised from seeds of the same variety when in the prime of its existence. If, in addition to the debilitating effects of old age, a variety has been subject to various adverse influences, such as forcing its growth by an excess of manure, cutting its tubers into sets, placing the cut surface on manure, heating the tubers in pits, &c., all these would exercise an

injurious influence on the health of the plants; consequently, on the health of the seed also. If, moreover, the seeds are imperfectly ripened, and the young plants are improperly reared, a similar effect would be produced, viz., a diminution of constitutional vigour. Again, in a plot of seedling potatoes the most vigorous and productive plants have smooth and polished leaves and coarse tubers; we reject these, and select for cultivation those plants which have crumpled leaves, and tubers of a dry, mealy quality. Now if, as Mr. Knight has concluded, the difference observed in the vigour of these plants "tends to prove that the smooth leaf is a more perfect and efficient organ than the rough one, the latter indicating some degree of approximation to disease," it is probable that, by propagating exclusively from the farinaceous and less vigorous varieties, we may, by this means, also, have gradually impaired the health of the potato plant. Many causes may thus tend to diminish the constitutional vigour and hardiness of the potato, and if these causes are allowed to exercise their influence through successive generations, the result is inevitable; the time must assuredly arrive when even plants recently obtained from seeds will be so tender and susceptible of disease, as to render it impossible to cultivate them with advantage. No other explanation than this seems adequate to account for the progressive deterioration of the potato. The tubers of other plants which are propagated in a similar manner, are kept out of the ground during winter; yet, as I shall hereafter show, no such degeneracy in these plants, considered as species, has been observed. And, as for over-cultivation, which has also been frequently assigned as the cause of the deterioration of the potato, it might be asked, why should the effects of this be visible in the potato only, and not in other crops. Considerable improvement has, certainly, been made in farming of late years, but I am confident, that the most enlightened agriculturalists will agree with me in stating, that what may be called "high farming," is, even in this country, at the present time, the exception and not the rule. Our mode of preserving the tubers, and of cultivating the potato, has tended to diminish the health of varieties, but I believe it is chiefly to a want of the knowledge of, or faith in, the truth of the law that every plant propagated by extension has a limited existence, and to the consequent neglect of frequently raising new sorts from seeds of vigorous plants of healthy varieties, that the degeneracy of the potato in the mass, or as a species, is due.

An attempt has been made by two eminent botanists, to disprove the accuracy of the conclusions at which I had arrived, as to the causes of the blight of the potato, by endeavouring to show that Mr. Knight's theory respecting the limited duration of varieties of plants is not well-founded. Some of the arguments advan-

ced in support of this opinion are plausible, and calculated to influence many, but certainly not any one, I think, who is acquainted with the laws of vegetable life, and with the history of cultivated plants. A knowledge of Mr. Knight's theory is of importance to all cultivators, not only because by it we may learn what precautions should be taken in selecting our seed-bearing plants, but because it shows to us the hopelessness of striving against nature, by persevering in the cultivation of certain varieties of plants, when they have become aged, and no longer able to make an adequate return for the labour and attention bestowed on them. It is also desirable, that the evidence which has already been advanced respecting the wearing out of varieties of the potato, should be supported by evidence afforded by other species of plants propagated in like manner. And in order that this may be done, that the theory may be better understood generally, and that the fallacy of the arguments by which it has been assailed, with a view to overturn my explanation of the potato disease, may be exposed, I have considered it to be advisable to print an examination of the objections of the gentlemen referred to, which I forwarded to the Agricultural Societies early in 1846.

Do Plants propagated by extension, wear out?

Fifty years have now elapsed since the theory of the limited duration of varieties of plants propagated by extension, was promulgated by Mr. Knight, in a paper read before the Royal Society. Like most new and important views, it has had to pass through a searching ordeal of objections and criticisms, and not a little ridicule; but the truth of the theory is now generally admitted, and it seems, indeed, so reasonable, and so consistent with facts, that one might have supposed no objection would be raised to it at the present day, by any one whose knowledge of cultivated plants entitled his opinion to respect.

Scientific men, however great their attainments, are unfortunately not infallible. They occasionally arrive at false conclusions from insufficient data, and the history of science presents us with many an instance, showing that when once a hasty opinion has been delivered, strenuous exertions have been made to maintain it, notwithstanding the most satisfactory proof of its fallacy: so ungracious a task it is for man to confess his errors.

Dr. Lindley commenced his two articles* in opposition to Mr. Knight's views by the question, "do the races of plants wear out?" instead of "do varieties of plants propagated by extension wear out?" The latter proposition presents a clear notion of the

* Gard. Chron. Dec. 13 & 20, 1845.

point at issue, the former is calculated to mystify those who were not previously acquainted with the subject.

I consider I may also reasonably object at the outset, to the mode in which Dr. Lindley met the arguments advanced by Mr. Knight and myself in this matter. In the Gard. Chron. of Nov. 15, 1845, Dr. Lindley said, "there is not only no proof of the correctness of Mr. Knight's views, but the strongest presumption to the contrary. It is superfluous to say, that the Golden Pippin Apple is the instance on which this theory mainly turns. It is said that it is worn out, and can no longer be cultivated," and then, after stating that comparatively healthy trees of it are yet known to exist, he concludes that, "the wearing out theory, therefore, falls to the ground." These remarks are obviously calculated to lead any one not acquainted with the writings of Mr. Knight, to suppose that he had arrived at his conclusions respecting the wearing out of plants, chiefly from observations on the Golden Pippin Apple. And, notwithstanding the many proofs I advanced, of the degeneracy of varieties of potatoes and other plants, Dr. Lindley, in the Gard. Chron. of the 20th of Dec., said, "Mr. Townley infers, because the gooseberry growers of Lancashire find that the weight of the fruit diminishes after the varieties have been cultivated some time, that these varieties are, therefore, dying of old age, and he has expended no inconsiderable quantity of learning in attempting to fit this speculation to the potato." The notion intended to be conveyed evidently is, that the conclusion that the varieties of plants do wear out, is founded on one or two isolated facts, which admit of a better explanation. No such expedient is required for the exposure of error, and in defence of truth. In my three letters in the *Herald*, there are only four lines in which anything is said about gooseberries, and I merely alluded to the fact, that the size of the fruit of a given variety is found to diminish in the course of time, as a well-known and satisfactory proof that varieties of other plants propagated by cuttings, decline in vigour as well as the potato.

With many of the conclusions arrived at in the Article of the 13th Dec., I cordially agree; for in order, as it would seem, to make a show of argument and refutation, the expedient has been resorted to of setting up certain foolish propositions, and then gravely proceeding by facts and arguments to show the fallacy of them. We are told, in the first place, that "it is alleged that seeds renew the languid vigour of a species as often as they are sown; and that, if an unhealthy plant is multiplied by seeds, the immediate offspring becomes healthy." Every one who has had much to do with the cultivation of plants, will be well assured that this opinion is opposed to all experience, and is obviously most unreasonable. The seedling may, for a short time, show greater vigour

than its feeble parent; but it is a fact of inestimable value and universal application, that from vigorous and hardy parents only can we expect robust and healthy offspring.

The next proposition examined is this: "it is also said that multiplication by seeds is the only natural mode of propagation known among plants." All will agree with Dr. Lindley, that "it would be difficult to find an hypothesis more entirely at variance with notorious facts;" yet, instances are actually cited to prove that plants do extend themselves naturally by runners and tubers, as well as by seeds. With a view to prove that all other kinds of increase than by seeds do not lead to debility, Dr. Lindley states that couch grass and the wild strawberry propagate themselves chiefly by runners, and that the Jerusalem artichoke has been propagated in this country by its tubers only, and where, it is asked, do we find any signs of debility in these plants. Couch grass is not a cultivated plant; therefore, from the want of accurate observations, whether an individual plant of couch grass does or does not wear out, is alike incapable of proof or disproof. Now, the wild strawberry has been cultivated, and Mr. Keens, a celebrated grower of strawberries, might seem to have anticipated the question, for he has recorded the following brief and decisive answer, "I have propagated the wood strawberry from runners, but never with such success as from seeds, particularly if the runners were taken from old roots."*

"The Jerusalem artichoke," it is said, "has been propagated by its tubers only, upwards of two hundred years, and it has never produced seeds in this country." This is very true; but when we come to examine the statement, what does it really prove? An oak may be more healthy and vigorous when five hundred years old, than an apple tree is at one hundred, or a gooseberry bush at twenty. But because an oak may be only in its prime at the end of five hundred years, we are not therefore to conclude that a gooseberry bush could not be suffering from old age at the end of forty years. So of bulbs: the onion plant dies in the second year; but varieties of the hyacinth are said to have been propagated by offsets nearly a century. Doubtless, there is a similar difference in the longevity of different species of plants propagated by tubers; and because the Jerusalem artichoke has been continued by this means two hundred years, we are not therefore to conclude, in the face of numerous and well attested facts, that varieties of the potato, or ranunculus, or anemone, cannot decline in vigour and wear out in a tenth part of that time. If we admit this, we must also believe that a sparrow cannot die of sheer old age in twelve years, because an eagle may live a

* Hort. Soc. Trans., 1817.

century. The truth is, that the Jerusalem artichoke is a much longer lived plant than the potato, and as the period of its duration is not yet ascertained, it is no evidence in this case. It must be remembered too, that the Jerusalem artichoke is not known to have produced seeds in this country. Now this is a most important consideration. It is well known that annuals may be made to live two or more years by not allowing them to blossom. There is a sort of onion which never attempts to blossom, it is therefore propagated year after year by offsets of the bulbs. Another variety called the 'tree onion' bears small bulbs on the top of the stems, instead of flowers and seeds, and by such it is propagated; yet these are merely singular varieties—they are of the same species as the common onion, only in consequence of their not producing seeds, they can be continued many years by means of offsets, whereas if they had produced seeds, the plants would have been exhausted in the second year. "The American aloe," as Professor Henslow has observed, "is a striking example of a plant, the ordinary period of whose existence may be very considerably extended by preventing its flowers from developing. In its native climate it comes into blossom when four or five years old, and afterwards dies; but in our greenhouses it continues to vegetate for fifty or one hundred years without showing any symptoms of putting forth its flowers."* And there can be little doubt that the length of time the Jerusalem Artichoke has been continued by division and without renewal by seed, will be owing, to some extent, to its not perfecting its seeds in this country.

And these are the facts which Dr. Lindley has selected to prove the following, "it is, therefore, not true that plants multiplied much, or wholly, by other means than by seeds, become on that account unhealthy."

The next proposition examined is, "seeds are said in all instances to produce healthy plants. But this, like the previous assertions, will not bear exact investigation." It is then argued that the health of a plant depends upon the seed, and Myatt's pine strawberry is mentioned as a striking instance of a plant with a decrepid constitution. Surely, no one can doubt all this. Myatt's pine strawberry, though affording fruit of unrivalled excellence, was eccentric in its habits, and could hardly be coaxed to grow from the very first; but varieties of the potato, apple, &c., are proved to have been not only of excellent quality, but healthy and vigorous at the beginning of their existence, and only became feeble and subject to disease in the course of time, which is widely different.

Having thus disposed of these mostly child-like notions, we now

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* Henslow's Botany, p. 238.

find Dr. Lindley complacently declaring, "we therefore regard the whole string of propositions now examined, as entirely destitute of all foundation in fact."

Next we arrive at most startling assertions, namely, "trees and other wild perennial plants have never yet been shown by any trustworthy evidence to be subject to decrepitude arising from old age. On the contrary, every new annual growth is an absolute renewal of their vitality. In the absence of disturbing causes from without, there is no intelligible reason why a forest tree should not continue to grow to eternity." If there be indeed no trustworthy evidence on record showing that trees become decrepid through old age, then surely trustworthy authors ought to have considered it idle and superfluous to insist on a fact which would seem to be so self-evident to every one who has ever enjoyed a woodland ramble. But has not the necessity of a rotation of crops been enforced by the reasoning that it is a practice conformable with the order of nature; that some of the early explorers of the forests of the New World for instance, had observed, where masses of aged trees of a certain kind were decaying, young trees of other genera were springing up to supply their place? And as to "every annual growth being a renewal of the vitality of trees," it is an annual transition from passive to active vitality, but it cannot be said to be a *renewal* of vitality, any more than the awakening of a dormouse or other hybernating animal, can be said to be a renewal of its vitality. It is the same vitality throughout life, only differing in power as the measure of life progresses, and maintaining its ascendency for a longer or shorter period according to the original vigour of the constitution, and to the adverse or favourable circumstances to which individuals may be exposed. Thus we find a tree in its youth grows with rapidity, exulting as it were in its vigour and health; as it reaches maturity the exuberance of its growth is checked, and its energies are chiefly directed to the production of fruit or seed; as old age advances, the foliage is first seen to become meagre; blossoms are more seldom followed by fruit; a moderate crop of fruit is attended with great exhaustion, from which the tree slowly recovers; the young shoots become more feeble and shorter; next the extremities of the branches begin to decay; the fruit is irregularly ripened, and of inferior quality; mosses, lichens, and canker seize upon the wood; parasites infest the leaves; insects lend a helping hand in the work of destruction; birds hasten the work by searching and digging for the insects; water and air are thus introduced; thus all these various causes combine to reduce the aged tree to its kindred dust.

Dr. Lindley cannot deny all this, but then he must contend that the decay and death of a tree are not a consequence of age or

diminution of vitality, but "arise from external not intrinsic causes." The soil, he says, becomes exhausted, the roots wander into uncongenial soil, food is withheld, and the elements conspire against the doomed tree. But can this be said of a plant like the wild strawberry? Do not its runners each year occupy fresh soil? and if an individual plant could be propagated by extension for ever, the strawberry should certainly be one of those plants. Now there are other trees and shrubs which propagate themselves by suckers; and Dr. Lindley must know that Mr. Knight alluded to the growth of such plants in support of the conclusion he had arrived at respecting the limited duration of a variety of apple, pear, &c. "The aspen," Mr. Knight observed, "is seldom seen without a thousand suckers arising from its roots; yet this tree is thinly, though universally scattered over the woodlands of this country. I can speak from experience," he adds, "that the luxuriance and excessive disposition to extend itself in another plant, (the raspberry) decline in twenty years from the seed."* If the diminution of vigour which precedes decay, was owing to external and not to intrinsic causes mainly, then the raspberry should go on and on, extending its circle like the fungi of a fairy ring, never resting while there was any fresh soil to occupy; and the last plants should be as vigorous as the first, for surely it cannot be said that the diminution of the vigour of a plant which extends itself in this manner, can be owing to the intrinsic causes above mentioned.

In the same soil a gooseberry bush may live fifty years, an apple tree two hundred, a pear four hundred, and an oak one thousand. If external influences only, determine the existence of a tree, why this difference? Why does not the hardy gooseberry growing under the same circumstances, live as long as the oak? It is because the influence which chiefly determines the existence of different species is inherent, and not dependent solely upon external circumstances. And if it is the inherent vitality, or constitutional power, which limits the duration of an individual tree, then, obviously, all cuttings taken from that tree inherit the same constitutional power and tendencies; and the healthy existence of the plants raised from the cuttings, must be nearly co-equal with that of the original tree, providing it died from the infirmities of age.

The truth is, the same law prevails in the vegetable as in the animal kingdom. For wise purposes different periods of existence are assigned to different species of plants, as well as to different species of animals; but it is obviously a law of nature that none shall live for ever. Some species of animals run their course in a few hours or days, the life of others extends beyond a century,

* Knight's Phys. and Hort. Papers, p. 84.

but the end of all is death. So of plants: some spring into existence, fructify, and die within a week; the life of others is limited to five or six months; and so the period of existence gradually extends until we come to the monarchs of the forest, which may boast of a life of one thousand years and upwards. But because they have lived so long, are we then to conclude that there is no limit to their existence, that they form an exception to all other organic beings; and that they can never suffer decay through the infirmities of age? Certainly not. A more unwise or inconsistent supposition never entered into the mind of man. The lordly oak labours under the same irrevocable decree as the humble weed,—dust they are, and unto dust they must return.

Other instances are now cited of cultivated plants having been propagated by extension a considerable time without wearing out. The white buttery pears of France are said to have been propagated by division from time immemorial, and exhibit no trace of debility." There is obviously something very unsatisfactory in this statement. French writers might with equal truth say, that white heart cherries, or pink-eyed potatoes, or golden pippin apples had been cultivated in this country from time immemorial. There are, however, many varieties of white heart cherries, and pink-eyed potatoes, and there are at least two sorts of golden pippin apples now known, and it is evident from Mr. Knight's remarks and Parkinson's description, that another golden pippin apple existed previously to the present old variety. But why go to France for evidence about pears? The trees of our oldest varieties are well known to exhibit unequivocal signs of decrepitude, and Mr. Knight has stated, that every experiment which seemed to afford the slightest prospect of success was tried by himself and others, to propagate the old varieties of the apple and pear which formerly constituted the orchards of Herefordshire, without a single healthy or efficient tree having been obtained.* The duration of a variety of the pear is supposed to be about four hundred years. Possibly this period, even supposing one variety only was alluded to by French writers, is amply sufficient to constitute a "time immemorial."

Dr. Lindley further remarks, that some vines which are supposed to have been in existence in the days Columella, have been transmitted by division to the present day. This, like the Jerusalem artichoke, would seem to many a formidable objection. The fact that some varieties of the vine had been propagated by cuttings a considerable time, was the chief reason advanced several years ago by an eminent writer with a view to prove that Mr. Knight's theory was erroneous, but it tended in no small degree to convince me that truth was on the side of Mr. Knight, for the

* Hort. Soc. Trast., 1824.

value of a theory is made manifest not only by the strength of the arguments on which it is based, but by the fallacy of the arguments by which it is assailed; more especially if the assailant is a man of acknowledged ability and acquainted with the subject on which he writes. Now even supposing that the conjecture is true, that some vines of the present day are the same varieties mentioned by Columella, surely an impartial inquirer after truth must be ready to confess, that this seemingly formidable objection is in reality no objection whatever, seeing that this vine is one of the longest lived plants known. Nay, so long will an individual plant of the vine live, that Loudon says, "the age to which the vine will attain in warm climates is so great as not to be known. It is supposed to equal or surpass that of the oak."* If the longevity of the vine does surpass that of the oak, then there is obviously nothing improbable in the supposition, that a plant of the vine which was living in the days of Columella might, if not destroyed by violence, be living now, therefore, it is perfectly consistent with Mr. Knight's theory, that varieties of the vine mentioned by Columella may have been continued by division to the present day. And yet because varieties of this long lived plant have been propagated by cuttings during centuries, we are required to believe, that varieties of the potato and other short lived plants propagated in like manner, do not wear out and become feeble in consequence of age, but that with due care they may be made to live for ever!

Dr. Lindley next touches on the apple; he has referred to three English varieties, which are supposed to be in the winter of their age; the Golden Pippin, Golden Harvey, and the Redstreak. Respecting the Golden Pippin he states that healthy trees were many years since shown to exist in Norfolk; and in warm dry places this variety has no particular appearance of suffering. Trees of it are growing vigorously in Madeira. It is also growing in France, whence trees have been brought to England, which are said to be recruited by the fine dry climate of the former country, and this is considered to be a conclusive answer to the wearing out hypothesis. But previously to arriving at this positive conclusion, Dr. Lindley should, if only out of respect "to the memory of Thomas Andrew Knight," have stated that Mr. Knight was perfectly well aware of the effects of various circumstances on the old sorts of fruit trees; that "they seemed," for instance, "like invalds to enjoy the benefit of a better climate." When speaking of the potato, I said, if the diminution of vitality consequent on old age, is the primary cause of dry rot in certain varieties, then every adverse influence to which they were exposed must contribute more or less to their destruction, and favourable

* Ency. of Gard.

circumstance would of course exercise an opposite influence. So it is with aged fruit trees. Mr. Knight observed, that "a gravelly or wet soil, or a cold preceding summer, or a high exposed situation, adds much to the virulence of disease;" on the other hand he states, "it appeared probable that the latter period of the existence of the apple tree would be *considerably prolonged in a southern climate*, for all the old varieties succeeded best in warm situations, and the most diseased flourish with the greatest vigour when trained to a south wall." And yet with such observations as these by Mr. Knight on record, Dr. Lindley would fain persuade us, that because trees of the Golden Pippin in a comparatively healthy state yet exist in France and in Madeira, and in warm dry places in this country, therefore this variety is not declining in vigour and wearing out.

The Golden Pippin was formerly a general favourite. Mr. Knight says, "it was very extensively planted in Herefordshire, before the end of the seventeenth century, and many very large orchards of it remained in the middle of the eighteenth century; and as long as the tree possessed even a moderate degree of health and vigour, the Golden Pippin retained the character of a very prime cider apple. But owing to the debilitated state of the variety in which the vital principle seems nearly expended, much of the fruit generally remains imperfect and immature, and almost all the cider which it has afforded within the last twenty years has been crude or thin, or very frequently acetous. No attempts to propagate it as a cider apple are now made in Herefordshire, though many trees of it of very large size still remain.*

If this apple then was formerly grown with so much success, and was so highly prized for its qualities in Herefordshire, and if varieties of plants do not in the course of time become debilitated, and more susceptible of disease and injury from adverse influences, then why, in the name of common sense, does not the Golden Pippin now flourish, yield excellent cider, and grow to a tree of a very large size, in the same soil, the same climate, and with the same treatment, and still continue to be an universal favourite in that county?

Mayhap the good people of Hereford have made too much of it, have petted and praised it so long, that it has become proud of its great name, and fastidious respecting its local habitation, and must now have the most comfortable dwelling places in sunny nooks or southern climes, or it will become unhappy and pine and die. Why, such an explanation as this would scarcely be more unreasonable than to say, in the teeth of facts like these, that varieties

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* Knight's Pomona Herefordiensis.

of plants propagated by extension do not wear out in consequence of debility and disease arising from old age.

Respecting the Golden Harvey, Dr. Lindley says, "it is in all good gardens." So it may be. Of this variety Mr. Knight says, "the trees of the Golden Harvey still possess a considerable share of health and vigour, and for culture in the garden only, it is not much impaired by age."

Of the Red-streak Dr. Lindley says, "it is little known to him, and he has no evidence about it." But if varieties of the apple do not deteriorate and wear out, how is it that this, once the most famous cider apple known, is now all but extinct? Now, it is of importance to prove that varieties of plants, which were propagated by extension and have disappeared, or nearly so, formerly possessed such a combination of good properties as to make it highly desirable to continue them for ever, if possible.

That the Red-streak was held in great estimation may be inferred from Phillip's poem, named "Cider."

> Let every tree in every garden own
> The Red-streak as supreme, whose pulpuous fruit
> With gold irradiate, and vermillion shines.

The good John Evelyn speaks of it as "the famous Red-streak;" and again, "the Gennet Moyle was once preferred to the very Red-streak." "The Moyle of sweetest honied taste." It is also apparent by other remarks, that Evelyn considered the Red-streak had no rival in this or any other country. With regard to health and productiveness, Evelyn observes, "the Red-streak will at three years old graffing, give you fair hopes, and last a hundred years, if from sundry men's experience of more than sixty years, we may divine." When comparing the merits of the Golden Pippin with the Red-streak, he says of the former, "it is in no wise so proper for a cider orchard, not half so soon bearing, nor so certainly, nor in that quantity, nor in that fulness or security; for as it (the Red-streak) is no tall tree, so it is less exposed to blasts and the like." Then, respecting the quality of its cider. In papers on cider and cider apples, published with Evelyn's Pomona, one writer says, "among cider apples the Red-streak bears the bell." Another observes, "the cider of the summer Red-streak is of a wonderful fragrant and aromatic quality." Evelyn mentions that a Mr. Taylor of Herefordshire challenged a London vintner that he would produce a cider which should excel his best Spanish or French wines; "the wager being deposited, he brings in a good Red-streak to a private house, and all the vintner could call to be judges, pronounced against his wine." The vintner not being satisfied, two other wagers were entered into, but with a like result. I may now

adduce proofs of the decline of this once famous apple. In Martyn's Edition of Miller's Dictionary it is said, "the Red-streak, so much celebrated by the writers of the last century, appears almost to have survived its fame as a cider apple." Mr. Knight, in his Pomona Herefordiensis, observes, "trees of the Red-streak can now no longer be propagated; and the fruit, like the trees, is affected by the debilitated old age of the variety, and has in a very considerable degree, survived those qualities to which was owing its former fame; the cider which has been made of it alone, within the last thirty years, having rarely proved good."

Here, then, we have most satisfactory proofs of a once famous apple; handsome, hardy, productive, and affording cider of surpassing excellence; having become feeble, diseased, and almost, if not quite extinct. Such, then, when they come to be examined, are the facts and arguments advanced by Dr. Lindley, in support of his assertion that "there is not only no proof of the correctness of Mr. Knight's theory, but the strongest presumption to the contrary."

As in the case of the natural death of forest trees, the facts are too numerous and too well authenticated, proving that valuable varieties of plants propagated by extension, have ultimately become diseased and unproductive, and consequently extinct. Dr. Lindley cannot do otherwise than admit these facts; but he rejects the reasoning, and protests against the inferences. Of course, then, he is bound to furnish us with more satisfactory and conclusive reasons in support of the inferences he would have us to draw from them. And what is the explanation which is to supersede this "extraordinary exhibition of false reasoning" of Mr. Knight, and those who entertain his views? Here it is. "The obvious interpretation of the apple tree and gooseberry bush cases, which have so perplexed the minds of the little patriots of our day, is this: a tree is allowed from some cause or other to become unhealthy, a piece cut from it and put upon another tree carries its disease with it; when again divided, the disease is again propagated; and this will go on so long as the unhealthly plants remain exposed to the circumstances which originally caused their bad health."

Adverse circumstances certainly tend to make plants unhealthy. A variety of apple which has been in existence two hundred years, must have been exposed to a greater amount of damaging influences than a variety which has been in existence only fifty years; therefore, according to Dr. Lindley's argument, we may reasonably conclude that the old variety, owing to the effect of these adverse external influences alone, must be less healthy and less suited to the purposes of the cultivator than the younger variety. Dr. Lindley may say, if he pleases, that varieties do not

become unhealthy because they are old, so long as he admits that old varieties do become unhealthy. He may tell us that disease does not arise from internal but external circumstances. But the question will intrude, how are we to avoid these circumstances? What is the "some cause or other" which makes them unhealthy? If the plants of a variety in a certain locality only became diseased then we might have some grounds for hope, but when we remember that "of the apples mentioned by Parkinson, the names only remain," and when we now know that old varieties of the apple and pear decline in vigour and productiveness throughout the country, first in cold, wet, ungenial soils; lastly in dry, warm, situations; how are we to prevent this? "Change the circumstances," says Dr. Lindley, "place the plants in more favouable circumstances; keep off the cause of the evil, and the evil will gradually disappear as in the case of the Golden Pippin." Again we may ask, what is the nature of the evil we are to avoid? what are the circumstances we are to change? Is a plant hospital in the south of France or Madeira contemplated? What other means are we to resort to, seeing that the Golden Pippin is the only instance mentioned of trees of an almost worn out variety of fruit existing in a comparative state of health; and knowing, as we do, that Mr. Knight and others have tried every experiment which seemed to afford the slightest prospect of success to propagate some of the oldest varieties of apples and pears, without a single healthy or efficient tree having been obtained.

The duration of both animal and vegetable life depends upon the original vigour of the constitution, as well as adventitious circumstances. There are inherent as well as external influences with which we have to contend. Thus of human beings; many die in infancy, others may live a century. Of ten thousand born, hardly one may die through exhaustion of vitality, or sheer old age; I mean, without the exhibition of any active disease. Again, of two children born with equally vigorous constitutions; one whose constitution has been subject to many trials may die in forty years, whilst the other more favourably circumstanced, may live double that time. In like manner individual seedling plants differ greatly in constitutional vigour. Some we find are so feeble that the first adverse influence to which they may be exposed destroys them, whilst other plants of the like kind and age, growing under the same circumstances, remain unharmed. Why is this? Because of the difference in constitutional vigour. Some external influence may have been the immediate cause of death, but the inherent feebleness of the plant was the predisposing cause which led to its destruction. So of plants with originally vigorous constitutions; few may die simply of exhaustion of vitality; a tree in the prime of its existence may become unhealthy

and diseased from various external causes, the soil may be wet or otherwise unsuitable, the roots may wander into an ungenial subsoil, or the leaves in an adverse season may be attacked by fungi, &c. But improve the soil, replant the trees, and prevent their roots from reaching the sub-soil, or let the fungi disappear, and the plants being sound at heart, if I may so speak, will, owing to their inherent strength, be restored to better health; exactly as in the case of animals in the prime of life, labouring under local or transitory circumstances affecting their health. But we may graft a scion of an old unhealthy tree, on a healthy young stock, we may plant it in a situation where trees of the same variety continued previously in health and vigour upwards of a hundred years, and where younger varieties now grow healthy and vigorous, but "the young stock," as Mr. Knight, observed "can give nutriment only, not new life;" it is found therefore, that the feeble scion, like a weak seedling, soon shows symptoms of disease. It may be said, external influences first caused the feebleness, but this may be said quite as reasonably of the infirmities of age in animals. It is inherent weakness only in both, which renders the attack of ordinary external influences formidable.

When a variety of apple or potato has arrived at the best and most productive period of its existence, is it rational to suppose or expect that the ingenuity of man can keep it stationary for ever, and prevent its decline? The inherent and many of the external influences which lead to debility and death are beyond the control of man. Like the dropping of water on a stone, every adverse influence to which plants or animals are exposed, contributes more or less to prostrate and wear out the constitution; and the power of external influences increases in proportion to the diminution of vital power. Man, by various expedients, may postpone the evil day, but he cannot prevent its coming. He may, for instance, betake himself to Italy or Madeira in order to bolster up his feeble constitution, and he may take plants of his favourite old invalid fruit trees with him, as a warmer climate is found to be as beneficial to them as to him, and both may return to their native land considerably fortified, but certainly not restored to the vigour of youth.

Proofs of the degeneracy of varieties of the potato are, as in the case of apples, pears, &c. too numerous and too well established to admit of doubt. Dr. Lindley, therefore, offers an explanation of these facts also, which he would gladly have us to substitute for that of Mr. Knight. "A potato forced in rich land," he observes, "has a feeble constitution, and a small matter makes it ill; its unhealthiness is communicated to its successors, and so the evil is ceaselessly augmented." He further remarks, "after six months unnatural treatment during winter, the tubers are committed to

the ground, the farmer thus plants the germs of disease; and though we have no reason whatever to connect this practice with the blight, yet it is impossible to doubt that such a practice long persevered in, must have a tendency to diminish the constitutional vigour of the crop."

The measures recommended by Dr. Lindley, to restore the potato to its pristine vigour, I have previously noticed, and proved them to be of doubtful value. But lest any one should comfort himself with the belief that growing the seed tubers in poor ground, and keeping them there during winter, will restore the present varieties to health, and that there is not, therefore, any necessity for raising new varieties from seeds, other evidence must be advanced to prove that Dr. Lindley's explanation is not of itself adequate to account for the bad health of varieties of the potato, and that his remedial measures alone, cannot possibly prove efficient.

Can it be considered probable that this method of renovating the health of aged or diseased varieties of the potato should have escaped the attention of Mr. Knight? He knew well the pernicious effects on the progeny, of over-feeding our domestic cattle with a view to premiums, as one of my letters from him testifies,* and doubtless, no man was better aware of the injurious effects of an excess of food and other influences on plants. Then consider the attention which he obviously paid to the culture of the potato, the unusual care and diligence with which he conducted all his inquiries, and the anxious desire he ever manifested to arrive at

* An opinion is obviously gaining ground among the more intelligent practical farmers, that it is doubtful policy to appropriate so large a portion of the funds of Agricultural Societies, to premiums for animals. They consider the money might be better employed, by encouraging improved cultivation of the land, and that the fat condition in which stock is usually shown, not only causes a waste of food, but is likely in the course of time to prove otherwise injurious. Mr. Knight's observations above referred to seem so full of practical wisdom, that I am induced to print them in support of those who entertain similar just views on this question. "I have employed much time and trouble, and a good deal of money, in ascertaining how animals may be made to assume in breeds those forms which enable them to bear most labour with least food, and to fatten at the least expense, and in the least time; and I have found that much may be done; and indeed I have done much. But Agricultural Societies are too much in the habit of giving prizes to large *over-fed* young animals; and the offspring of such animals require to be fed, or more properly over-fed, like their parents; and consequently, some Agricultural Societies have, through ignorance, done much injury, by giving existence to breeds of animals that usually come to market *insolvent*, that is, not paying the cost of their feeding. Well-managed Agricultural Societies have done much good. In breeding animals of almost all kinds, too much attention has been paid to size and show: our horses are generally from a hand to a hand and half too high; and the labour which they can do is generally very highly paid for."

the truth, by repeatedly trying experiments from which he suspected results unfavourable to the conclusions at which he had arrived. The object, moreover, which he constantly had in view, was utility. To be useful to his country and his fellow men, by discovering important truths in cultivation, was the aim of all his inquiries. Yet, with such qualifications as these, and when near the close of his invaluable labours, and after fifty years at least of experiments and observations on plants, Mr. Knight said, " I have in several instances tried to renovate the vigour of old and excellent, nearly expended varieties of the potato, by *change of soil and mode of culture*, but I never in any degree succeeded."

Some have rashly asserted, that Mr. Knight was a "mere theorist," but so far as the cultivation of plants is concerned, it may be safely said, that in no other individual was there such an union of "practice with science." "No man living now before the world" (was the just observation of Dr. Lindley) "can be said to rank with him in that particular branch of science to which his life was devoted." Yet, notwithstanding, Mr. Knight, with his profound knowledge of the laws of vegetable life, was foiled in his repeated endeavours to re-invigorate old varieties of the potato; the peasantry of this country are seriously told, that to think of renovating the potato crop by raising new varieties from seed, is a dream, and that, if they will only adopt certain methods, they may restore old varieties to health and vigour, and so continue them healthy and vigorous for ever.

The failure of Mr. Knight and others, to restore varieties to health, is not the only ground for doubting the efficacy of the means recommended by Dr. Lindley. If the feebleness of the constitution of the potato were a consequence chiefly of its being grown in too rich land, or frequently repeated on the same land, surely the garden varieties should have been most subject to disease; for gardens generally are much more highly manured than fields, and there the crop is most frequently repeated. But early varieties seem, upon the whole, to have been more free from disease than late or field varieties. There has not, moreover, been the same high farming in other countries as in this, of late years. The produce of the arable land of America, for instance, which has been some time in cultivation, has been progressively decreasing, owing chiefly to the want of attention to manure, yet this disease of the potato has been fully as virulent in that country as in this.

Varieties of the Anemone and Ranunculus are also exempt from many of the causes which Dr. Lindley says must be avoided in the future cultivation of the potato, with a view to restore it to health. The tubers of these plants are not gathered into heaps, and suffered to heat during winter; they are not allowed to grow

before planting in spring, consequently, no useless sprouts are rubbed off; they are not planted on raw manure, nor are they cut into sets, therefore there is no loss of sap, or danger of injury from external causes arising from that practice. Yet, notwithstanding these advantages, and notwithstanding the care and skill bestowed upon them by the ardent florist, varieties of these plants unquestionably degenerate and wear out.

Our first authority on the Ranunculus, Mr. Tyso, a gentleman who has raised thousands of this beautiful flower from seeds, observes that, "The longevity of the Ranunculus has been variously stated. Some of the finest seedlings are weak, and, therefore, die in a few years, though for a time they had great renown; others of first-rate character are remarkably strong, and increase abundantly. A variety may be perpetuated about a century. Many of the varieties, standing high in the esteem of florists forty years ago, are fast declining in numbers and energy; they now bloom less frequently, or produce smaller blossoms. Seedlings possess all the luxuriance and vigour of youth, and produce larger and finer blossoms than the old varieties."* Similar observations might be quoted from papers by Dr. Horner, M. Lymburn, and other cultivators of this flower.

Another high authority on these matters, minutely describes the effects of age on varieties of the Anemone. "The constitution of Anemones," says Mr. Maddocks, "undergoes considerable changes with age, which is, perhaps, in a greater or smaller degree, the case with all other vegetables. The Anemone will not last more than twelve or fifteen years without degenerating, unless it be frequently removed to a different soil and situation; nor will any removals protract or prolong its existence more than thirty or forty years. It generally blooms in greatest perfection from the fifth to the tenth or twelfth year, after which it gradually becomes smaller and weaker, and if the flower was originally full and double, with age it loses that property, the petals diminish in number, become small and irregular, and, finally, the sort perishes. It has more than once occurred, that the same sort, although in the possession of many persons residing at remote distances from each other, has been entirely lost in one season, without the possibility of accounting for it in any other manner than the above."†

Surely, no one can now be persuaded that it is foolishness to think of renovating the potato crop by raising new varieties from seed. We find, on enquiry, that Mr. Knight's theory, instead of being supported by "an extraordinary exhibition of false reasoning," is based on numerous indisputable facts, the results of

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* Gard. Chron, June 22, 1844. and Tyso's Pamph. on the Ranunculus.
† Maddock's Florist's Directory.

repeated experiments and observations by himself and other practical men.

I learn, by the report of a discussion in Scotland, respecting the potato blight, that a northern botanist, who was appointed to inquire into the cause of the disease, "devoted his address to the solution of the important question, 'Do plants die out?' He affirmed that the theory was an exploded one, and altogether untenable, and proved this by a reference to the immense variety of apple trees derived from the common crab, and to the cabbage, cauliflower, and broccoli plants, as originally belonging to one stock." Now this gentleman was obviously not aware of the nature of the question at issue with reference to the potato, and which he so confidently pronounced to be exploded and untenable. I cannot for a moment believe, that he has wilfullly mis-stated the case; but one of the two is certain, either he did not understand, or he has mis-stated.

It is true, that our cultivated apples are generally considered to be the descendants of the wild crab; and that the wild cabbage of the Dover Cliffs is the origin of the many garden varieties of the cabbage tribe. Every plant in a state of nature seems to be capable of being progressively improved by the skill of man. An improved variety of cabbage or cauliflower, which is continued from year to year, by seeds only, not by cuttings, may, with certain precautions, be continued equally healthy and valuable for ever. We know nothing that justifies a different conclusion. But they who have read so far need not be told, that the question to be decided is not, do species or races of plants propagated exclusively by seeds, die out and disappear; but can an individual plant, one variety of apple, potato, ranunculus, &c., be continued by cuttings or tubers equally healthy and vigorous for ever. This is Mr. Knight's theory; that a *variety* of any plant propagated by extension, that is, by buds, cuttings, layers, or roots, and not by seeds, will utlimately decline in vigour, become unproductive and worthless, and, consequently, extinct. Now I go a step beyond Mr. Knight, I contend that the potato in the mass, or considered as a *species*, has also degenerated, and will wear out if means are not adopted to stem its downward progress.

By a judicious selection of seed-bearing plants through successive generations, a variety of cabbage may be progressively improved, by adopting the opposite course—by saving seeds from the plants indiscriminately a variety will deteriorate, that is, a highly improved variety of the cabbage would gradually lose its character by retrograding towards the primitive type, nevertheless the cabbage being propagated by seeds only, the deteriorated plants might be perfectly healthy. But, as I have before remarked, if we continue a variety of the potato by cuttings, until the

vitality is nearly expended, or if by our imperfect mode of culture we render the plants of a variety unhealthy, and then save seeds from it, successive generations must inevitably become less hardy.

Even men who were insisting that varieties of the potato do wear out, and that new varieties should be raised to supply their place, have saved seeds from their old favourite varieties when in a degenerate and diseased condition,* so unconscious were they of any evil results likely to follow. If instead of this, new varieties had always been raised from the most healthy and vigorous kinds only, and when in the prime of their existence, say from the fourth to the tenth year, I can see no satisfactory reason why the potato should not have been as hardy and healthy now, as when first introduced, and why it should not be so continued for ever. All other agricultural plants have progressively improved, the potato alone has progressively deteriorated. The former are propagated exclusively by seeds, the latter chiefly by divisions of the tuber, and this difference in the mode of propagation furnishes a key to the true explanation of the cause of the bad health of the potato as compared with other crops.

There is no other instance of an entire species of plant having degenerated like the potato. The varieties of the Ranunculus and Anemone are equally short lived plants, but great attention has been paid to rasing new varieties from seeds. To raise new sorts of these flowers is a most bewitching, and, moreover, a profitable pursuit, and florists know well that in order to reach nearer to perfection, they must start from the most perfect flowers they most recently obtained. But there have been no inducements for continued efforts to improve the potato, by raising new varieties from seeds year after year. Other plants had far higher attractions for those who followed the pursuit as an amusement; and as a commercial speculation there was little prospect indeed of its paying; hence, we have been trying over and over again, with a marvellous perversity, to make individual plants live for ever, which Nature intended should only live for a time; and then from parents feeble or old we have vainly expected offspring hardy and strong; herein we have violated the laws of Nature; by these practices we have gradually reduced the constitution of successive generations of the potato; and we have consequently gradually increased the activity and power of those influences provided by Nature, to rid the earth of feebleness, and to admonish and correct those who act in opposition to her immutable laws.

In conclusion, I would appeal to the numerous intelligent practical gardeners, scattered throughout the country, and to

* See Holt's remarks, in a Report on the Potato by the Board of Agric. High. Soc. Trans. 1837, p. 505. Quart. Jour. of Agric. vol. 10.

gentlemen who are attached to horticultural pursuits, for active co-operation and aid in this inquiry. Gardening is allowed to be one of the most delightful and elevating recreations which can occupy the leisure hours of a rational being; but the pleasure of raising new varieties of fruit, or perennial flowers and vegetables from seeds, can only be appreciated by those who have felt its power, and the enjoyment is enhanced by the knowledge, that even by your amusements you may contribute to the welfare and happiness of thousands—all require vegetables, all admire flowers. But how much more powerful must the stimulus to exertion now be, when so much depends on the solution of the problem, whether the potato plant can be restored to health by carefully raising a succession of varieties from seeds. Unfortunately, no arguments are now required to prove the importance of the question in an economical point of view; it is highly important as a question of science; and of painful importance to thousands, whose welfare, it may be their very existence, depends on the regeneration of the potato. And should the efficacy of the remedy be confirmed by further and more extensive experiments, then, not only will many immediate advantages be gained, but another triumph will be achieved over Nature; another step gained in advance; another beacon of world-wide utility will be raised as a warning to succeeding generations.

For the sake of truth and the general good, I trust that many will feel it to be an imperative duty to try promptly and fairly to regenerate the potato, by means which evidently offer such well grounded hopes of ultimate success.

As the letter which Mr. Knight addressed to the Editor of the Preston Pilot, is probably the last he published on the utility and culture of the potato, and on the wearing out of varieties of the plant, I have considered it advisable for this and other reasons to insert a copy of it in this publication.

(From the Preston Pilot, of January 7, 1837.)

TO THE EDITOR OF THE PRESTON PILOT.

Downton, Dec. 30th, 1836.

SIR,

I have recently received two copies of your paper,* for which I suppose myself to be indebted to your highly enlightened

* Dec. 3 and 17, 1836.

correspondent, "I. T." My opinions coincide with his, respecting the causes of the failure of the crops of potatoes in different parts of the United Kingdom in the last season; and I trouble you with a letter, only under the impression that I have some facts to communicate, which may prove interesting to him and to the growers of potatoes generally.

That varieties of potatoes which have been long cultivated cease to be equally productive, is placed beyond the reach of controversy; and the farmer before he resolves to cultivate any variety, should make himself acquainted with its history, and with its habits, by inspecting its growth and habits in the preceding year. I have in several instances tried to renovate the vigour of old and excellent, nearly expended varieties by change of soil, and mode of culture, but I never in any degree succeeded, and many of the tubers of some of these varieties perished without vegetation, and all become unproductive and worthless. An inquiry, therefore, respecting the best means of obtaining new varieties is important.

I have usually preferred propagations from such varieties only as do not ever naturally afford blossoms, and from the offspring of such I have obtained the heaviest crops which I have ever seen. About four years ago, I obtained from one of these, a produce equivalent to 1284 London bushels, of sixty pounds weight, and a fraction, per statute acre; but the quality of the variety was not good. The last season was unfavourable on account of the drought of the summer; but I nevertheless obtained a produce equivalent to 1018 bushels, and a fraction, per acre, of potatoes of first rate excellence. No mistake respecting the produce above mentioned could have occurred; for the crops were taken up in the presence of the farmers and gardeners of the vicinity, and weighed by them; all the exterior rows, and the ends of all the other rows, having been previously taken away, because the plants growing in these had more than their due share of light.

These varieties were all of rather dwarfish growth and of early habits relative to their growth in the spring, and in their season of maturity; and your well-informed correspondent will readily see that such varieties, under appropriate culture, must be most productive. The food which the plant absorbs from the soil, is carried up by the woody part of its stem into the leaves, where it becomes the true sap, or living blood of the plant; and from the leaves it descends by the bark, and gives existence to and feeds the tubers, and the mature leaves only, and of those such only as are not shaded by others are efficient. When the stems of the varieties are short, the distance which the sap will have to travel, and consequently the time required for its ascent, and

descent will be short also, and by planting the rows at distances proportionate to the length of their stems, the whole ground will be covered, and all the foliage will be mature, and prepared to act during the long and bright days of summer; and no portion of the sap will be expended in the production of blossoms or seeds. I scarcely need add, that such crops as those above mentioned, can only be obtained from well manured ground.

Varieties of more luxuriant growth and such as are calculated for field culture, and for use in the following year, are best obtained from seeds of varieties of similar habits, but for such purposes I prefer preparations from those varieties which do not naturally afford seeds; and I strongly recommend operating upon a few blossoms to trusting to such crosses of breeds as may incidentally take place between varieties growing contiguous to each other. Comparatively few varieties which will be found to deserve permament culture, can be obtained under the best management, and the tubers of some of the newest varieties will be found to perish without vegetating when planted.

Your correspondent is perfectly right in recommending the tubers to be planted below the manure, when that is to be put in the rows with them; but I strongly disapprove of the practice of putting the manure in the rows with the potatoes, and I believe that your correspondent will think my objections well founded. The young plants grow very freely at first, because their first emitted roots find abundant nutriment, and those roots consequently extend rapidly, but they extend into the unmanured soil, and if that be not rich, it cannot afford food. Abundant machinery will consequently exist with a scarcity of raw material, and the produce of tubers will naturally be found defective, comparatively, with the growth of the plants.

The cause why very early varieties of the potato never blossom, appears obviously to be, that the tubers form preternaturally early, and draw off the sap, which under ordinary circumstances is expended in giving existence and nutriment to the blossoms. This of course cannot occur in varieties of late habits and luxuriant growth, but I have obtained from seeds several, and some of great merit, which do not ever (apparently owing to malorganization) afford blossoms.

I have been led to make a great many experiments on the potato plant, with the hope of obtaining improved varieties for different seasons of the year, under the impression that good potatoes, with a moderate quantity of meat, will afford more palatable and more wholesome food, as well as cheaper, than can ever be obtained from wheat; for I had observed, that the peasantry of this country became more healthy, and more long lived, when the potato obtained almost exclusive possession of

of their gardens, than previously; and it is well known that in those parts of France where the peasantry live almost wholly upon bread, their lives are very short, and are likewise unhealthy.

The quantity of animal food which the British Islands are capable of producing is enormously great. A thousand imperial bushels of potatoes, such as I have described, if given properly to hogs of proper age and size, and of good breeds, will afford much more than a thousand pounds of pork; and if all the manure produced be put upon the soil, the same acre of ground will for ever remain at least equally productive. Change of soil, under such circumstances, not being necessary or advantageous—the same matter which composed one potato, being perfectly well adapted to form another. Wheat, on the contrary, is an exhausting crop, and it cannot be raised in any considerable increased quantity, without injury to a large portion of landowners; and as one of those, I wish to see a very extensive alteration of the existing corn laws.

I remain, Sir,

Your obedient Servant,

T. A. KNIGHT.

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